E ENGINEERING CONSTRUCTION WEEKLY

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NOV 5 1937

Engineering NEWS-RECORD

November 4, 1937

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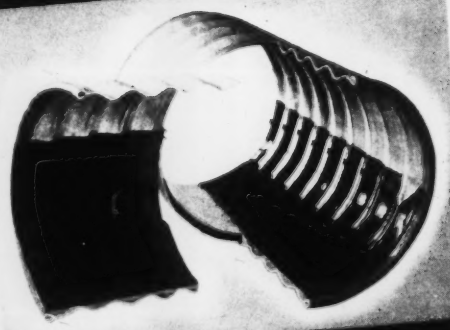
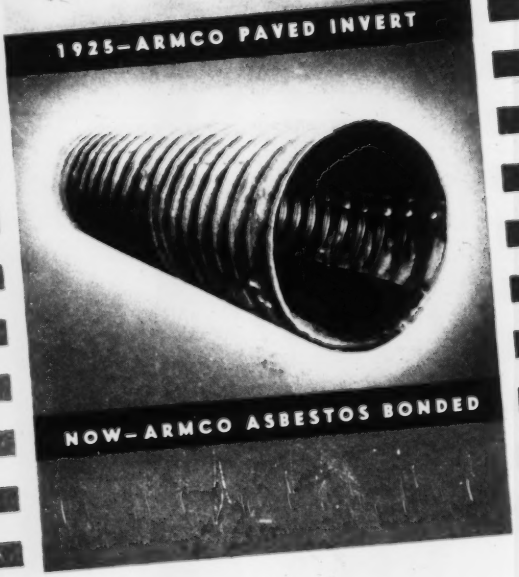
These ARMCO Improvements Assure Longer Lasting Drainage

1906—ARMCO INGOT IRON



1925—ARMCO PAVED INVERT



NOW—ARMCO ASBESTOS BONDED

"LOOK UNDER YOUR ROADS"

FROM THESE PICTURES you can readily see how Armco engineers have increased the durability of corrugated metal pipe. But the real "proof of the pudding" is under your roads.

That's why Armco invites you to inspect all types of drainage structures *in actual service*. Check performance for yourself. Then there won't be any question in your mind about which type of structure, or which metal, gives the *most service for your money*.

Thirty years of experience has convinced us that "looking under your roads" is the strongest advertisement in the world for the *extra values* built into corrugated metal pipe by Armco engineers. When shall we arrange an inspection trip? Armco Culvert Mfrs. Association, Middletown, Ohio.

ARMCO

One Cause of "Engineered Murder"

A COUPLE OF WEEKS AGO, in the *Chicago Tribune*, Hal Foust reported on a visit to the sites of serious motor accidents along the Lincoln Highway. "The safety organizations," he says, "are inclined to concentrate their efforts on correcting faulty driving. However, on the Lincoln Highway, the Tribune roadster found faults in the road which might be easier to correct than man's proneness to mistakes."

These faults included soft shoulders, deep ditches, blind intersections, narrow winding road on steep hills, narrow bridges and culverts and other inadequate design. Mr. Foust describes the route as "not a highway, but a hard surface on a pioneer trail."

The same famous route crosses Ohio, where about the same conditions prevail. And recently the *Cleveland Press* has featured a series of highway articles by Robert Bordner. They are entitled "Engineered Murder!" Mr. Bordner says in part:

"Blindly the public fumbles with quick cures—more laws, more police, more safety campaigns. These are no cures, although they slow the slaughter locally and temporarily, and the policing has an important part to play in the permanent cure. * * * Meanwhile a few voices have been shouting the right answer—unheeded. * * * Most engineers would be delighted to do the job right if the public demanded it. * * *

"Fifteen per cent of the drivers have nearly 100 per cent of the accidents. * * * Faults of the automobile contribute to more than 15 per cent of these accidents, and faults of road design to the great majority * * *"

MR. BORDNER believes that the obvious answers to the problem "include separation of opposing traffic, grade separation, limited access to main routes, approach lanes for merging traffic and other features of improved design.

"All this," he continues, "looks as though it were merely road engineering in its application. It is much more. It engineers the human element into a position where it just can't commit more than a very few freak accidents." He asserts that more than 99 per cent of our highway investment has come to be "an obsolete contrivance for congestion and slaughter." He reminds us that of the 3,300,000 miles of rural road less than 9 per cent carries 65 per cent of the traffic and that less than 4 per cent carries half the traffic, and he cites Chief MacDonald of the Bureau of Public Roads as authority for his belief that "redesign of a small portion of the present system and design of a few new portions will clean up the worst of the mess."

"The cost is the rub," he concludes. But he recalls that "there is $1,000,000,000 a year being collected in motor taxes, gasoline, registration and carrier fees. The large sections of this that were diverted to other than highway uses during the depression will be coming back to highways under the pressures now growing.

"With this billion a year and another billion and a half that can be saved in damage and slaughter by the improvements, this society of ours has a good start toward rehabilitating this $15 billion investment."

THUS Mr. Bordner on the feature page of the *Cleveland Press*. But alas for his optimism, one need but turn to the editorial page of the same newspaper to find this:

"Money for Poor Relief—Spokesmen for the state administration who would have it appear that the state government does not have the wherewithal to meet the emergency poor relief demands presented by the state's subdivisions apparently expect us to ignore the pot of gold in the State Highway Department which the politicians have been distributing among their friends with such bountiful generosity.

"Yet here would seem to be the one place to get the money for 1937 relief needs without the necessity for a painful operation.

"The Highway Department has approximately $12,500,000 in its maintenance and construction funds. That part of the fund already obligated probably will be offset by November and December gasoline tax collections, although there is some prospect a number of existing contracts may be held illegal and release even more money than is now anticipated. In any event, $5,000,000 can be appropriated from the road funds without doing any damage. * * *"

None, that is, except to prolong Mr. Bordner's "engineered murder" and to confine the "painful operations" to the bodies of its victims.

Willard Chevalier

ENGINEERING NEWS-RECORD

Published every Thursday. Vol. 119, No. 19. Price 25c per copy. Subscription, domestic, Canada, Mexico, Central and South American countries, $5 per year. All other countries, $9 a year or 36 shillings. Entered as second-class matter October 29, 1936, at the Post Office at Albany, N. Y., under the act of March 3, 1879. Printed in U. S. A. Cable address "McGrawhill New York." Member A.B.P. Member A.B.C.

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Editorial and Executive Offices: 330 West 42d St., New York. Publication Office: 99-129 N. Broadway, Albany, N. Y. Branch Offices: 520 N. Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, W. C. 2, England; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.

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Dutch Boy Red-Lead comes in both paste and liquid form, the latter including a quick-drying type for use when allowable drying time is short. The pigment in every case is pure red-lead that contains more than 97% Pb_3O_4, thus assuring easier application, higher spreading rate and a uniform film of greater density.
For complete information on protecting iron and steel against corrosion, send for our free booklet, "Structural Metal Painting." It covers such subjects as the conditions affecting the life of paint on metal, proper paint formulation, testing and judging the value of paint, estimating areas and costs.
• • •
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111 Broadway, New York; 116 Oak St., Buffalo; 900 West 18th St., Chicago; 659 Freeman Ave., Cincinnati; 1213 West Third St., Cleveland; 722 Chestnut St., St. Louis; 2240 24th St., San Francisco; National-Boston Lead Co., 800 Albany St., Boston; National Lead & Oil Co. of Penna., 316 Fourth Ave., Pittsburgh; John T. Lewis & Bros. Co., Widener Bldg., Philadelphia.

· ENGINEERING NEWS-RECORD ·

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Editorial and Executive Offices: 330 West 42nd Street, New York . Publication Office: 99-129 North Broadway, Albany, N. Y.

F. E. SCHMITT, *Editor* ALBERT E. PAXTON, *Manager*

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VOL. 119 *NOVEMBER 4, 1937* No. 19

THIS WEEK AND NEXT

FROM REVOLUTIONARY TIMES the west side of Manhattan Island has been pushed farther and farther into the Hudson River until now at points several hundred feet of "made" ground reach toward the New Jersey shore. The problem of sinking West Side Highway foundations through the many types of fill materials constituting this ground was met by almost every known method and by some previously little-known methods.

Contractors frequently have lost money on government contracts because of delays and interferences caused by government agents. Two Washington (D. C.) attorneys cite several cases in which the contractors have recovered damages, and give practical rules of procedure for contractors thus damaged.

Two elevated tanks, each providing 3 million gallons of storage for Sacramento, are built of reinforced concrete and are earthquake proof.

Lewis H. Tuthill states that satisfaction of construction's need for better concrete mixers must come through a concerted demand upon the manufacturers for improvement. Principal shortcomings of mixers now built are given and improvements to be made are offered by Mr. Tuthill on page 756.

When the Rock Island Ry. truss spans over the Kansas River at Manhattan, Kansas, were washed out in the 1935 flood, much of the steel was left buried in the river bed. How the members were located and blasted to make room for the piers of a new highway bridge is told by LaMotte Grover.

NEXT WEEK—Carnegie-Illinois *breaks away from tradition in building a new steel plant on hilltops.*

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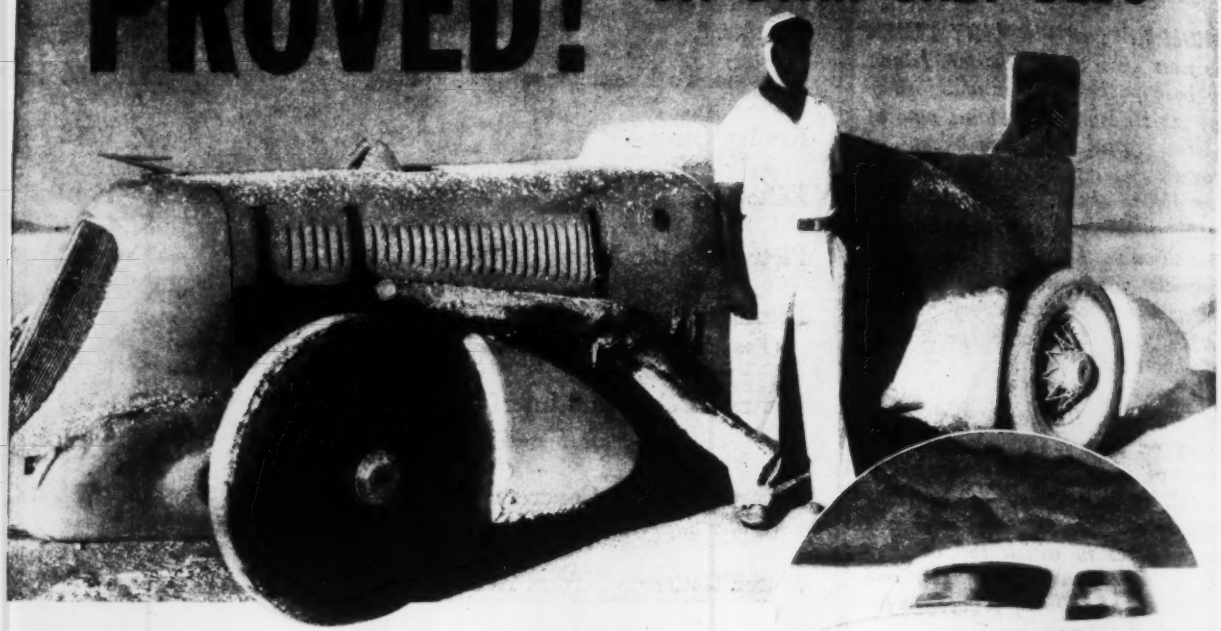
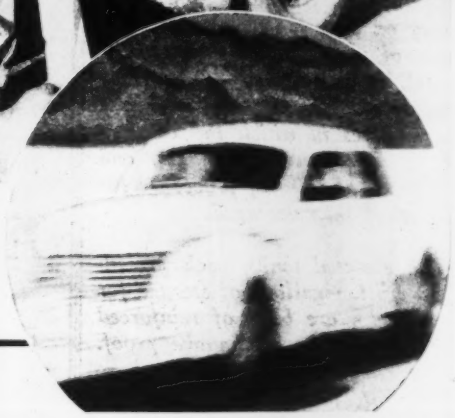
THE COVER PICTURE shows the cutting edges of rotating caissons described in the West Side Highway story on page 743. In the background is the 900-hp. rotating rig that turns the shell into a giant drill.

Number of copies of this issue printed: 30,042

GULF DEPENDABILITY PROVED! ON UTAH SALT BEDS



87 world and international speed records were smashed by Ab Jenkins in his powerful racing car shown above—raising world's unlimited 24-hour record to average of 157.27 m.p.h. He also broke the 1-hour record at a speed of 177.05 m.p.h.



Car driven by Ab Jenkins photographed while breaking 36 "unlimited" and 36 "Class C" stock closed car records—all well above 100 m.p.h. For 24 hours he averaged 101.72 m.p.h.

Ab Jenkins sets 159 new speed records.... using Gulfpride Oil and No-Nox Ethyl Gasoline

(Supervised and timed by the Contest Board of the American Automobile Association)

NO special lubricants or fuels were used by Ab Jenkins when he recently hung up 159 new speed records with his big racer and his stock car sedan on the Bonneville salt beds in Utah.

He used the same Gulfpride Oil and Gulf No-Nox Ethyl Gasoline that are giving thousands of car owners new motoring economy and satisfaction every day! *The same gas and oil you can buy for your car from any Gulf dealer!*

Gulfpride Oil has unique qualities which make it an ideal lubricant for all operating conditions. It is refined by a special process — Gulf's exclusive and patented Alchlor process — which removes 20% more waste, carbon, gum and sludge-forming elements. The result is an oil of greater stability, greater resistance to oxidation, better lubricating qualities and longer life.

This same refining process is used in the preparation of Gulf's finest industrial lubricants. Thus, operators of steam turbines, air compressors, Diesel engines and many other types of industrial equipment can secure for their engines and machines the same protection against friction, wear and repair expense that Ab Jenkins received from Gulfpride Oil when he made 159 new speed records in Utah. GULF OIL CORPORATION · GULF REFINING COMPANY, GENERAL OFFICES, PITTSBURGH, PA.

GULF INDUSTRIAL LUBRICATION

· ENGINEERING NEWS-RECORD ·
NOVEMBER 4, 1937

THE WEEK'S EVENTS

PWA Housing Jobs In New Hands

U. S. Housing Authority takes over jurisdiction of 51 projects and staff of 600

The federal government's low-rent housing drive under the Wagner Act got under way last week with the official transfer, by executive order, of all projects, property, funds and personnel of PWA's Housing Division to the new U. S. Housing Authority, which started to function Nov. 1 under the leadership of Nathan Straus.

Involved in the transfer are about 600 employees, two-thirds of whom are in Washington, and 51 projects providing 76,274 rooms to house 21,776 families. These are located in 36 cities in 23 states, the District of Columbia, the Virgin Islands and Puerto Rico, and will cost a total of $134,033,400. (For technical reasons the two Puerto Rico projects will be retained under PWA jurisdiction.) All of these will be completed by the summer of 1938; 22 projects are now finished and will be occupied in the near future.

So far the management of the completed units is in federal hands, with the single exception of New York City's Williamsburg Houses, which has been leased for one year to the New York City Housing Authority. The language of the statute directs the Housing Authority to divest itself of management "as soon as practicable" by the sale or lease of the projects to local housing authorities. This is interpreted to mean as soon as such local authorities can be established and given a reasonable degree of financial stability in the respective areas.

• • •

Chicago Is Denied Review Of Activated Sludge Case

The U. S. Supreme Court on Oct. 25 refused to accept an appeal brought by the Chicago Sanitary District in the activated sludge patent infringement case started by Activated Sludge, Inc., of London, 13 years ago. The U. S. Circuit Court of Appeals recently held that the district had infringed upon patents held by the British company. The district appealed to the Supreme Court, asserting that the use of oxygen for the purification of sewage is a matter of common scientific knowledge and attacking the theory upheld by the lower court that a natural law "might be lawfully patented by one who first observes its utility."

Now that the Supreme Court has refused to review the decision, the case will be returned to the district court for an accounting. In a similar case, a district court recently fixed damages for patent infringements of nearly $5,000,000 against the City of Milwaukee.

NOMINATED

EDWARD P. PALMER, of the contracting firm of Senior & Palmer, Inc., New York City, has been nominated for the presidency of the Associated General Contractors of America. For the past two years, Mr. Palmer has been vice-president at large of the association. Election of officers will take place at the Annual Convention to be held in Washington, D. C., next February.

Old Building Floor Fails in Minneapolis

Two men are killed and 13 injured as overloaded floor of three-story building falls

A portion of the third floor of an old brick building in Minneapolis, which was used as a combination warehouse and office building by the Morris Fruit Co., collapsed Oct. 27. Of the 40 persons in the building, two were killed and thirteen injured.

The building, in the market district of the city, is a three-story solid brick wall structure about 40 ft. by 100 ft. in plan. It was built 41 years ago in 1896. The interior floors were supported by a row of columns down the center of the building spaced 20 ft. apart and carrying a longitudinal girder, dividing the floor into bays 20 ft. by 20 ft. Joists spanning across the main girder and spaced 3.5 ft. apart were built up wooden beams 7 in. by 12 in. The crosswise joists were set in the side brick wall about 6 in., giving a bearing area of about 40 sq.in. A 2-in. rough floor was laid on these joists and over that a finished floor.

The right-hand side of the first and second bays, viewing the building from the front, were unloaded. On the left-hand side, the first two bays carried a load of about 240 lb. per sq.ft., consisting of 52-lb. cases of ginger ale stacked six and seven high. The safe load for this floor, as figured by the Minneapolis building inspector, is 90-100 lb. per sq.ft.

In the failure, the front bay on the loaded side gave way. The load shifted toward the front wall, and it appears that the joists broke at about the quarter point from the wall. The second loaded bay did not fall and held its load.

The panel which fell broke through the second floor and damaged the first floor but did not go through into the basement. The first and second floors are used as offices by the fruit company.

None of the columns and girders failed and, except for one panel which dropped, the floors of the building are intact.

Regional Staff For PWA

Subordinate positions filled in new regional PWA staffs replacing state offices

Continuing the reorganization of PWA on the basis of seven regional offices instead of the previous set-up by states, Administrator Ickes has announced the appointment of personnel to serve on the regional staffs. All appointments are made from the existing field staff of PWA.

The new regional field staffs took over the operation of the PWA program on Nov. 1. PWA now has under construction, contract, or allotment nearly 3,000 projects involving construction with a total estimated value of about $2,000,000,000.

The new regional staffs are as follows:

Region No. 1 at New York City: Assistant director, Frank R. Creedon, formerly project manager; associate director, George D. Andrews, formerly state director of Pennsylvania; engineer, George P. Stowitts, formerly a chief engineer in the central office. Mr. Andrews will remain at Harrisburg in a regional sub-office.

Region No. 2 at Chicago: Assistant director, Garland L. Rounds, formerly state engineer-inspector for Illinois; associate director, Louis A. Boulay, formerly state director for Ohio; engineer, Forrest M. Logan, formerly state director for Indiana. Mr. Boulay will remain at Columbus in a regional sub-office.

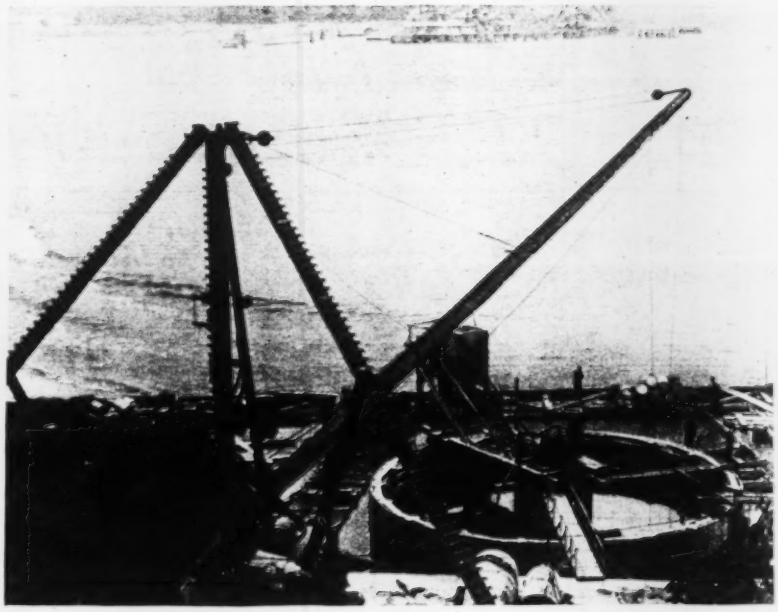
Region No. 3 at Atlanta: Assistant director, J. L. M. Irby, formerly state director of South Carolina; engineer, Stanley H. Wright, formerly state director of North Carolina.

Region No. 4 at Omaha: Assistant director, Joseph D. Evans, formerly state engineer-inspector for Nebraska. The engineer has not yet been appointed.

Region No. 5 at Fort Worth: Assistant director, Gustavus C. Street, formerly state engineer inspector for Texas; engineer, Alexander Allaire, formerly state director of Arkansas.

Region No. 6 at San Francisco: No director has yet been appointed for this region; Kenneth L. Godwin is temporarily acting director. Other officers are: Assistant director, Julian W.

(*Continued on page 737*)



A CAISSON FOR THE VANCOUVER BRIDGE

PREPARING a circular caisson at the north end of the First Narrows Bridge across the harbor at Vancouver, B. C. The north main pier caisson is now down 40 ft. in the gravel and has about 30 more ft. to go. On the south side, one of the two big circular caissons for the main pier has been sealed and the water pumped out. Erection of steel on the north approach span is starting early this month, and it is expected to start steel work on the main span early in January.

Contractors for the substructure on the bridge are Stuart Cameron & Co. The Dominion Bridge Co. is building the superstructure. This bridge is being financed by British capital.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY *ENGINEERING NEWS-RECORD*, IN OCTOBER, 1937

Engineering News-Record *reports projects of the following minimum cost: Water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000.

Four Weeks — Thousands of Dollars (000 Omitted)

Public Works	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States October 1937	United States Ten Months 1937	United States Ten Months 1936	Canada
Waterworks	219	549	198	350	324	611	**2,251**	59,179	81,734	30
Sewerage	.....	1,312	25	961	836	278	**3,412**	79,686	102,995	90
Bridges	1,099	6,189	309	1,510	1,026	687	**10,820**	106,658	145,974	146
Earthwork and waterways	.....	609	1,908	1,362	2,879	1,625	**8,383**	90,626	155,646	932
Streets and roads	1,576	6,955	4,845	8,428	9,185	2,749	**33,738**	354,014	420,358	1,321
Buildings, public	690	10,313	3,448	2,563	4,083	1,783	**22,880**	267,072	390,476	763
Unclassified, public	525	2,036	921	159	238	1,119	**4,998**	120,831	95,072	1,118
Total public	**4,109**	**27,963**	**11,654**	**15,333**	**18,571**	**8,852**	**86,482**	**1,078,066**	**1,392,255**	**4,400**
Federal government (included in above classifications)	114	1,775	2,353	2,449	4,001	3,058	**13,750**	174,856	275,516	.....
Private										
Bridges, private	25	546	.....	25	.....	.....	**596**	7,145	11,141	.....
Buildings, industrial	983	14,787	6,840	15,479	1,730	1,506	**41,325**	447,905	228,034	7,247
Buildings, commercial	1,700	32,549	265	10,068	2,591	2,795	**49,968**	401,140	228,335	375
Unclassified, private	1,050	738	1,555	4,197	2,191	1,699	**11,430**	141,553	98,036	751
Total private	**3,758**	**48,620**	**8,660**	**29,769**	**6,512**	**6,000**	**103,319**	**997,743**	**565,546**	**8,373**
Total Engineering Construction										
October, 1937 (4 weeks)	**7,867**	**76,583**	**20,314**	**45,102**	**25,083**	**14,852**	**189,801**	.....	.....	**12,773**
September, 1937 (5 weeks)	10,078	68,614	24,623	44,778	41,784	20,634	**210,511**	.....	.....	9,172
October, 1936 (5 weeks)	13,665	73,997	31,715	35,920	37,840	26,996	**220,142**	.....	.....	8,092
Ten months, 1937	97,924	906,547	207,064	359,636	299,074	205,564	.....	2,075,809	.....	115,541
Ten months, 1936	125,936	639,716	255,291	332,059	366,858	237,941	.....	.....	1,957,801	79,179

THE CURRENT TREND

This week's news of contract volume and construction cost factors

THIS WEEK'S FIGURES

(Thousands of Dollars)

CONTRACTS

	Week Ending Nov. 5 1936	Oct. 28 1937	Nov. 4 1937
Federal	$3,285	$4,640	$2,949
State & Municipal	19,553	22,476	10,553
Total public	$22,838	$27,116	$13,502
Total private	7,233	35,750	8,925
TOTALS	$30,071	$62,866	$22,427

Cumulative
1937 (44 weeks) $2,098,236
1936 (45 weeks) $1,987,872

Note: Minimum size projects included are: Waterworks and waterways projects, $75,000; other public works $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1936 45 Wks.	1937 44 Wks.
NON-FEDERAL	$805,069	$1,334,188
State & mun. bonds	433,345	436,590
Corporate securities	210,138	480,533
PWA loans, grants	136,528	178,126
RFC loans	24,908	29,939
Fed. aid for highways	.....	200,000
FEDERAL	$691,237	$746,223
TOTAL CAPITAL	$1,496,246	$2,080,411

ENR INDEX NUMBERS

COST			VOLUME		
Base = 100	1913	1926		1913	1926
Nov., 1937	244.95	117.55	Oct., 1937	167	73
Oct., 1937	244.55	117.55	Sept., 1937	148	65
Nov., 1936	212.70	102.24	Oct., 1936	178	78
1936 (Av.)	206.46	99.24	1936 (Av.)	185	81
1925 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50

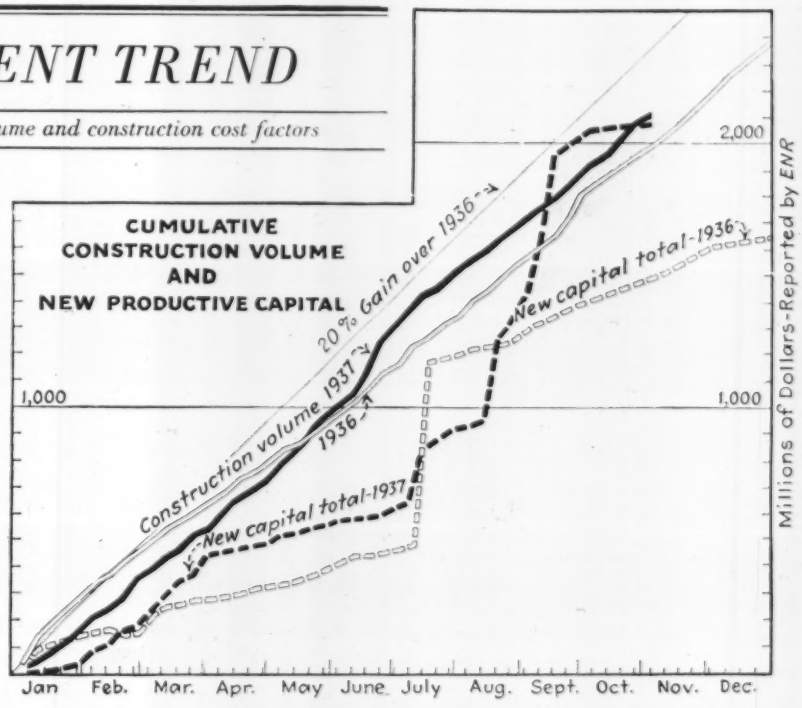
Business Briefs

ABERTHAW INDUSTRIAL BUILDING Cost Index (New England) dropped 1.7 per cent to 197.6 for the third quarter of 1937. Lower building material costs are credited for the decline; labor rates remained stable.

INDEX OF SHIPMENTS of construction materials reported by Projects Division, Public Works Administration is 88 for August compared to 84 for July and 95 for August 1936, based on 1929=100.

THE AMERICAN APPRAISAL CO., cost index for September remains at 185, the same as for the preceding two months. This value is 12 per cent higher than September, 1936.

VALUE OF DEEP WELL WATER system shipments amounted to $240,144 in August, compared to $229,098 a year ago. Shallow well water system shipments totaled $489,161, compared to $436,836 last August. Value of pump shipments was $257,136 for August, 1937, and $296,040 for last August, as reported by the Bureau of the Census.



THE MONTH'S SCOREBOARD

CONSTRUCTION VOLUME

(,000 omitted)	October 1936	October 1937	% Change	10 months 1936	10 months 1937	% Change
Total	$220,142	$189,801	+8	$1,957,801	$2,075,809	+8.5
Private	75,647	103,319	+71	565,546	997,743	+81
Public	144,495	86,482	−25	1,392,255	1,078,066	−21
Federal	21,628	13,750	−21	275,516	174,856	−35

NEW PRODUCTIVE CAPITAL

(,000 omitted)						
Total	$93,071	$58,617	−21	$1,474,707	$2,073,522	+41
Private Investment	55,507	58,617	+32	634,381	919,234	+48
Federal (non-fed. wk.)	37,564	.....	.....	149,089	408,065	+180
Federal (fed. wk.)	.....	.....	.....	691,237	746,223	+10

CONSTRUCTION COSTS . . . WAGE RATES . . . PRICES

	Nov. 1936	Nov. 1937	% Change	Change Oct. to Nov. 1936 Oct.	1936 Nov.	%	1937 Oct.	1937 Nov.	%
ENR Construction Cost Index 1913 = 100	212.70	244.95	+15	211.50	212.70	+.6	244.55	244.95	+.2

ENR 20-CITIES AVERAGE

Common Labor	$.583	$.678	+16	$.583	$.583	0	$.676	$.678	+.3
Skilled Labor	1.178	1.382	+18	1.176	1.178	+.2	1.378	1.382	+.3
Bricklayers	1.228	1.480	+20	1.228	1.228	0	1.467	1.480	+1.
Struct. Ironworkers	1.228	1.425	+16	1.223	1.228	+.4	1.425	1.425	0
Carpenters	1.077	1.242	+15	1.077	1.077	0	1.242	1.242	0
Cement, per bbl.	$2.59	$2.51	−3.	$2.59	$2.59	0	$2.53	$2.51	−.8
Reinforcing Steel, new billet	2.67	2.91	+9	2.67	2.67	0	2.91	2.91	0
Struct. Steel, Pittsburgh	1.90	2.25	+19	1.90	1.90	0	2.25	2.25	0
Sand, per ton	1.18	1.22	+3	1.20	1.18	−1.7	1.22	1.22	0
Lumber, 2x4 Fir, per M	33.06	36.09	+9	33.23	33.06	−.5	37.02	36.09	−3
Lumber, 2x4 Pine, per M	30.93	31.88	+3	30.79	30.93	+.3	32.60	31.88	−2
Brick, Common, per M	13.90	14.12	+2	13.86	13.90	+.3	14.23	14.12	−1.3
Ready-mixed concrete	7.16	7.42	+4	7.14	7.16	+.3	7.42	7.42	0
Struct. Clay Tile, 3x12x12	72.65	72.95	+.4	72.65	72.65	0	72.85	72.95	+.1
Paving Asphalt, cars, ton	16.90	17.15	+1.4	16.90	16.90	0	17.15	17.15	0

MATERIAL SHIPMENTS

	October 1936	October 1937	% Change	Sept. 1937	Change Sept.-Oct.
Lumber (% 1929 wk. av. Shipments) N.L.M.A.	71	63	−11	65	−3
Steel A.I.S.I. (% Operating Capacity)	74.4	59.4	−20	75.6	−22

	September 1936	September 1937	% Change	Nine months 1936	Nine months 1937	% Change
Cement (Bur. of Mines) Thous. Bbl.	12,619	12,773	+1.2	84,289	89,839	+6.7
Fabricated Struct. Steel Shipments* A.I.S.C., Tons	145,521	154,295	+6.0	1,135,598	1,237,139	+9.0

*Subject to revision.

BUILDING PERMITS

	September 1936	September 1937	% Change	Nine months 1936	Nine months 1937	% Change
Dun and Bradstreets, (,000 omitted)	$88,696	$86,710	−2.2	$730,731	$851,605	+16.5

AFTER THE FLOOD IN MANHATTAN, KANSAS

IN JUNE, 1935, floods in the Kaw River in Kansas swept away the state highway bridge and the nearby Rock Island Ry. bridge at Manhattan, home of Kansas State Agricultural College. Today both of these old crossings are replaced with modern bridges, the highway structure being set on high piers so that the lowest steel work clears the flood mark by 4 ft. Some of the difficulties in constructing these piers are outlined on page 758 of this issue.

Designed by the state highway bridge department and financed in equal shares by state and federal government, the $425,000 highway bridge consists of several groups of continuous spans. The main river crossing is a continuous truss group of 132, 165, 198, 165, 132 ft. Girders are used in the approaches. The total length of the bridge is 2,039 ft., and it provides a 24-ft. roadway and two 3½-ft. sidewalks separated by a 20-in. high double curb.

Research Activity Told At Columbus

More than 250 delegates attended the Second Industrial Research Conference at the Ohio State University in Columbus held Oct. 22-23. Of these about 150 were executives and research engineers of various Ohio industries, the remainder being members of the university faculty and others interested in the subject of industrial research.

On the afternoon of the 22nd the delegates were taken on inspection tours of the University research activities and in the evening they attended an informal dinner sponsored by the Ohio Manufacturers Association at which President George W. Rightmire, of the University, presided.

A welcome was extended to the Conference by Charles F. Michael, President of the Ohio Locomotive Train Company and of the Ohio Manufacturers Association. Dr. Roy D. McClure, Surgeon-in-Chief of the Henry Ford Hospital, introduced W. J. Cameron, vice-president of the Ford Motor Car Company. Mr. Cameron addresed the Conference.

On October 23 the Conference was convened with Mr. Charles E. MacQuigg, Dean of Engineering of the University, as Chairman. Speakers were L. W. Wallace on "Research on the Rails", H. M. Williams, on "Developments in Refrigeration", R. K. Brodie on "Cottonseed Products", R. B. Sosman on "Research and Experimentation in Ceramics."

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Rail-Highway Bridges Asked In Northern Quebec

A request has been made by the Northwestern Quebec Mine Managers Association that the Quebec provincial government negotiate with the Canadian National Ry. with a view to having certain bridges on the new C.N.R. line through the northwestern Quebec mining area, constructed to carry both the railway and provincial roadways over the rivers which they cross. It was stated that C.N.R. officials had confirmed that there was still time for the bridge construction to be made a cooperative venture.

Bridges across the Thompson and Kinojevis Rivers were mentioned in particular, the existing ferries across these streams being already overtaxed. It was suggested a saving of about 50 per cent of the possible outlay on highway bridges across these two rivers would result from such cooperation between railway and province.

In addition to the new railway line, new road construction is also proceeding at present in the area as a result of mining activities there.

Two Die in Manhole Of Boston Sewer

Two maintenance employees of the Boston Metropolitan District Commission's sewer division lost their lives Oct. 22 while working in a regulating manhole at Spruce and Second Streets, Chelsea, Mass. The men entered the manhole to adjust a regulator which was temporarily out of commission, and in some manner were overcome by gases or drowned before rescue was possible. A third member of the crew was saved.

Three days later one of the bodies was found at the screen installation of the Deer Island pumping station, some 6 miles distant, having passed through an intervening trunk sewer of 110-in.x 100-in. cross-section, through a siphon about 5 ft. 8 in. in diameter under Chelsea Creek, past the screening equipment of the East Boston pumping station and through a large centrifugal pump in that installation. Except for the absence of clothing, little outward evidence of mechanical injury appeared. At this writing the second body has not been located, but an active search is in progress, including the shutting down and unwatering of the pumps at East Boston to facilitate a search.

The engineering firm of Fay, Spofford & Thorndike, Boston, has been retained by the commission to study the causes of this fatality.

Housing and Research Feature Steel Fabricators' Meeting

American Institute of Steel Construction reports active year in promotion, improvement of standards and technical studies

PAPERS on steel in house construction, on rigid frames and on factors in steel construction progress shared interest with reports on research and production statistics at the fifteenth annual meeting of the American Institute of Steel Construction, held at White Sulphur Springs, W. Va., Oct. 26 to 29. Fred T. Llewellyn, research engineer of the United States Steel Corp., New York, presented a comprehensive summary of information on light-gage flat-rolled steel in housing. H. W. Whittemore of the U. S. Bureau of Standards explained the test program covering house building materials and assemblies that is just getting under way in Washington. Harold D. Hussey, engineer of the American Bridge Co., New York, discussed the use of rigid frames in bridges and buildings. F. E. Schmitt, editor of *Engineering News-Record*, reviewed the progress of steel construction during its half century of existence and listed major elements of further progress of the art. He forecast a growth of normal annual volume of the industry within ten years to 4,000,000 tons, from present normal of 3 to 3½ million and a 1937 production of half this amount.

C. G. Conley, Mount Vernon Bridge Co., Mount Vernon, O., in his presidential address emphasized the value of cooperative effort in improving the service rendered by the industry; of particular value are the institute's statistical reports, cost studies and bid depository system. A higher level of business ethics can be attained, he said, on a cooperative basis than through N.R.A. methods.

As shown by the institute's statistical report, shipments of fabricated steel during 1937 were somewhat greater than the previous year, the 1936 total being 1,550,000 tons against a low of 828,000 tons in 1933 and a high of 3,300,000 tons in 1929. The price per ton received for fabrication last year was about $45, against $28 in 1933 and $53 in 1929. About half the current volume is from private buyers and half from public agencies.

Much technical research is in progress, according to the report of F. H. Frankland, chief engineer of the institute. He stated that the wind pressure and wind stress studies on the Empire State Building have been completed; a report is to be published soon. Tests of stress distribution in rigid-frame knees are still in progress, welded knees having been added to the riveted knees already tested and model tests having been begun as a check. The stress tests on "Battledeck" floor are completed. Plate girders are now under test in several laboratories, partly to check design methods and partly to study the behavior of flange and webb splices.

Since revision of the institute's specifications for steel construction in 1936, when the basic working stress was raised to 20,000 lb., 289 cities have adopted or permit the new stress. A new (third) edition of the Manual of Steel Construction, now on press, will furnish tables based on 20,000 lb. Revisions have also been made in the Institute Manual of Practice.

Mr. Llewellyn in discussing flat steel in housing stated that—"a total first cost which exceeds that of conventional construction by as little as 5 per cent is rarely obtainable," especially in low-cost housing, but he emphasized the advantage of low cost of maintenance. He described the system of American houses, Arcy, Berloy, Ferrocon, Ferro, Enamel, General Houses, Insulated Steel Construction, Lea, Lindeberg, Palmer, Phemaloid, Pre-Fab, Reynolds, Steelox, Stain-steel, Unibilt and Variplan.

The average weights of steel per sq. ft. of wall and floor surface are 1.45 and 2.05 lb. in those that use steel for framing only, and 5.25 and 4.55 lb. in those that use steel for covering also. Steel per room is 2,000 lb. and 5,000 lb. respectively. Present problems lie in assuring strength and stiffness in this sheet construction, in connections, in use of insulation for stiffening, in treating the wall joints, and in attaining lower cost.

Mr. Hussey reviewed the development of rigid-frame construction and summarized the stress measurement results so far obtained: "The stress in the web plate and flanges at the outside corner of the knee is very small (for angles of 90 deg. or less); the flange tension passes across the corner through the web plate, and the neutral axis is quite close to the inner corner." He stated that the most economical design is usually obtained by making the steel span as shallow as possible.

E. J. Russell, architect, St. Louis, speaking on construction industry prospects, asserted that the industry pays too little attention to construction trends, and suffers from too many high peaks and low valleys. Perhaps it can control these fluctuations, he said, as by requiring certificates of necessity from those who wish to build. The construction industry should take a hand in preventing unsound financing, for if a building is not needed or desirable it should not be financed. City planning alone can not accomplish all; it needs to be dovetailed into other efforts, particularly those that industry can make.

Further speaking on steel in housing, Mr. Russell stated the objective thus: "We should have incombustible buildings, vermin proof buildings, and buildings that will stand every wind." If steel is to be used as skeleton construction he acknowledged himself to be with the steel men 100 per cent, but in present house development efforts steel men are in danger of going too far and too fast for their own good. Finally, he suggested as a useful activity for the institute that it give certificates for conformance with its own construction standards.

All present officers of the institute were re-elected.

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Water Supply Protection Asked of Massachusetts

Representatives from New Hampshire, Rhode Island, New York, and Connecticut met recently with a special commission created by the Massachusetts legislature and urged the passage of legislation by Massachusetts which would protect the purity of water supply sources used by those states arising in Massachusetts. These states have already taken such action to protect the supply obtained by Massachusetts within their borders. The special commission was appointed for the purpose of formulating legislative plans providing like protection in Manhattan.

Neither New Hampshire nor Rhode Island obtain water from Massachusetts, but they desire protection in case they should do so at some future time. Connecticut seeks chiefly to guard against pollution of its streams.

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Wards Island Plant

In the account of the dedication of New York City's Wards Island sewage treatment work, (*ENR* Oct 28, 1937, p. 697), the name of Walter D. Binger, deputy commissioner of sanitation, in charge of engineering, who spoke at the ceremony, and who was in charge of the Wards Island project, was incorrectly given as Walter D. Burger.

LABOR NOTES

THE PEACE CONFERENCE between the A.F.L. and the C.I.O. adjourned for a week after a few days meeting, with its chief accomplishment the fact that the adjournment was not permanent. The C.I.O. proposed peace on a basis which would set up that organization as an autonomous department within the federation, keeping its own name and officers. The department would have jurisdiction in the mass production, marine, public utilities, service, and basic fabricating industries. The A.F.L. would declare as one of its basic policies that these industries should be organized on an industrial basis, and the agreement would be ratified by a convention of representatives of all A.F.L. and C.I.O. unions.

The federation thereupon presented a counter proposal that the C.I.O. be dissolved, that the original A.F.L. unions which organized the C.I.O. return to the federation with their former status, that the new unions chartered by the C.I.O. make their own separate agreements with the A.F.L. unions in their field, and that all major questions left unsettled be referred to the next convention of the A.F.L. The C.I.O. rejected the proposal and the meeting adjourned until November 4.

The complex dispute between the International Brotherhood of Electrical Workers, A.F.L., and the United Electrical and Radio Workers, C.I.O. (*ENR* Sept. 16, 1937, p. 454) as regards jurisdiction at the Ambridge, Pa. plant of the National Electrical Products Corp. reached a final settlement Oct. 19. A closed shop agreement with the A.F.L. union, which had been upheld by a district court, was challenged by the C.I.O., and the National Labor Relations Board ordered an election. The A.F.L. was the apparent winner in the election, but a considerable number of votes were challenged by each side. Now the N.L.R.B. has officially closed the case by certifying the A.F.L. union as collective bargaining agent.

A more orthodox labor dispute threatened to impede progress on the new $60,000,000 Irvin Works of the Carnegie-Illinois Steel Corp. near Clairton, Pa. Oct. 28, when about 175 carpenters, members of the United Brotherhood of Carpenters and Joiners, walked off the job charging that the Rust Engineering Co., a contractor on the project, was employing non-union workmen in the construction of a water intake system from the Monongahela River.

The employment of non-union men also threatened trouble in connection with reservoir-clearing operations above Alton Dam, one of the structures in the Upper Mississippi canalization project. St. Charles, Mo. officials of the International Hod-carriers, Builders, and Common Laborers Union asked James J. O'Brien, who holds the contract for the clearing operations, to use their men on the work at a 67½ cents per hour minimum, and threatened to picket the job when he stated that it would be necessary to bring his men from outside.

Efforts by union building trades workers in Columbus, Ohio, to prevent the servicing of jobs they worked on by non-union truck drivers were halted when the county court issued a temporary order restraining the Columbus Building Trades Council and its affiliated unions from interfering with the business of the Anderson Haulage Co. by persuading or instructing their members to stop work or threaten to stop work on jobs where the Anderson company delivers material.

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John Fritz Medal Awarded To Paul Merica

Paul Dyer Merica, director of research of the International Nickel Co., and vice-president of the International Nickel Co. of Canada, has been awarded the 1928 John Fritz Gold Medal for "important contributions to the development of alloys for industrial uses." The award is made annually for notable scientific or industrial achievements by a board made up of representatives of the four national engineering societies, civil, mining and metallurgical, mechanical and electrical.

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Subway Extension to Fair Put Under Contract

The first contract for the extension of New York City's municipally-owned Independent Subway System to the site of the 1939 New York World's Fair was awarded Oct. 28 to the P. T. Cox Contracting Co., for construction of a pile trestle, on its low bid of $309,000. The trestle will extend from the Jamaica yard at Forest Hills to a point near Horace Harding Boulevard.

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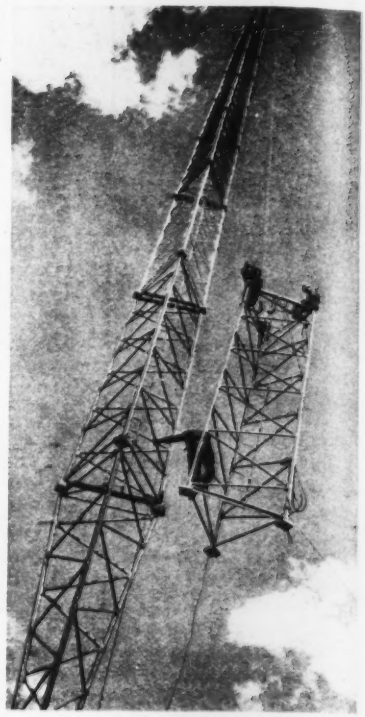
Elevated Highway Contract

In connection with the account of the award of a contract for the section of New York City's west side elevated highway, the name of the firm of Poirier & McLane, who are doing foundation work on the section of the highway between Duane and Cedar Streets, was incorrectly given as Poirer & McLane.



UP SHE GOES

LIFTING into place a section of the new 710-ft. tower-antenna put into service Oct. 30 by Station KDKA. The tower is composed of 32 three-cornered welded steel sections, bolted together. Held upright by two sets of guy wires, the tower, with a weight of 60 tons, rests in a ball and socket joint in a large porcelain insulator. This insulator, which is based on a concrete pier 10 ft. wide, has been tested to withstand loads of more than 100 tons. About halfway up, three smaller sectionalizing insulators have been inserted to break the antenna, electrically, at a height of 336 ft. Insulators are also inserted in the guy wire.

Last year an attempt was made to erect a similar tower 644 ft. high, but it buckled and fell. Since that time extensive testing has been given the new sections. Guy wire attachments are set in concrete piers 400 ft. from the base of the antenna. Two sizes of wire are used. The wires supporting the top section are 1-in. cable prestretched and tested to 52,000 lb.; the lower guy wires are $\frac{7}{8}$ in. cable tested to 41,000 lb. The top guys connect to the tower at the 526 ft. level and the lower guys at 270 ft.

The welded steel sections of the antenna are built of straight round bars with small round spacing bars placed at angles. These round members partially streamline the structure, reducing the winds load.

Unionism Discussed At A.A.E. Meeting

Engineers in Illinois consider advantages of a professional body over typical trade union

At the Illinois State Assembly of the American Association of Engineers at Peoria, Oct. 22 and 23, C. J. Ullrich, consulting engineer, Salt Lake City, discussed at length unionism and the engineering profession. He stated that the present sudden agitation for unionism within the profession is the outgrowth of three conditions; low economic level of many engineers, Wagner Labor relations act and the social and economic readjustments taking place under the New Deal. Referring to those in the *laisses-faire* group who feel that unionism is unethical he stated that he did not know what canons of the engineer's code of ethics those who organize for collective bargaining are violating. It is the methods pursued rather than the fact of organization that may be unethical in his opinion. Further he sees no difference between a practice that is unprofessional and one that is unethical.

Employee action needed

No hope can come from the employer class of engineers according to Mr. Ullrich. He added that L. C. Hill in his recent Am.Soc.C.E. address had outlined employer responsibility "very nicely". By the very nature of the situation wherein the employer must make a profit for himself or for the corporation by whom he in turn is employed Mr. Ullrich saw little possibility for change. While the law of supply and demand works as inevitably in the engineering profession as in other matters Mr. Ullrich feels that it need not necessarily do so insofar as salaries are concerned.

On the contention that unionism will forever divide the profession into employee and employer groups the speaker indicated that we already have the division. Organization for a better economic status would more clearly define the line of demarcation but would result in closer cooperation. However, Mr. Ullrich stated that in his opinion engineers who joined industrial unions are doomed to disappointment, their economic status would be lowered and they would find themselves engulfed in the working class. Since he feels that organization is essential he believes that the necessary pressure group can be established through one all-inclusive organization having the power to represent the entire profession and bargain for its welfare.

Unity within the engineering profession was the keynote of the whole convention with papers by a highway engineer, a chemical engineer, a mechanical engineer, a city civil engineer and an electrical engineer.

Program drafted

Following this state assembly the national board of directors met in Chicago and passed resolutions calling for: (1) Plans leading to a thorough-going classification of technical positions as a basis for adequate licensure of all professional engineers; (2) Integration of engineering in order that the profession may make available an authoritative body upon which the government may call for unbiased and expert evaluation of any great projects involving natural resources; (3) A federal department of public works manned by civil service employees; (4) Readoption of the stand on unionism taken by A.A.E. in 1919 wherein was set forth the doctrine of an increase in the demand for engineers rather than a limitation of the supply, rewards according to merit, increased production, responsibility of organization, organized representation for the correction of wrong, advancement of the profession and service to the public, and finally, rewards based upon enlightenment of public opinion, loyalty between employer and employees and a fundamental desire of the great majority to do what is fair and right when the merits of the case are clearly presented and demonstrated. The 18-yr. old resolution, which was signed by such men as W. H. Finley, F. H. Newell, E. T. Perkins, H. W. Claussen, L. K. Sherman, W. W. C. Sparrow, Alexander Potter, P. E. Harroun, J. H. Prior and John Erickson, had a definite statement that in the opinion of the signers an engineer could not subscribe to both the tenets of a trade union and to those of an organization composed of professional men.

The present board recommends that young engineers should not affiliate with an industrial or trade union but rather seek promptly and energetically solidarity in a national professional organization.

Painter elected president

C. E. Painter was elected national president and E. C. Shuman, vice-president. M. E. McIver, secretary-treasurer reported that income this last year exceeded expenses by several thousand dollars and that the membership had increased by 350 to 5,130. The employment bureau did ten times the business of last year and more than paid expenses of $6,000. The association classification indicates 60 per cent of its members are civil engineers.

Big Electric Building Lag Found by Committee

Pointing out that whereas the average annual construction activity in the electric utility industry between 1923 and 1932 had amounted to $752,215,000 but that during the years 1933-37 the average had been only $238,961,000, including an estimated $450,000,000 for 1937, the committee of utility executives stated Oct. 31 there now exists a "deficit" in construction of $2,600,000,000 and said that "next year's normal construction would justify an expenditure of at least $1,000,000,000."

The committee stated that this pronounced lag in utility construction was due to the federal administration's "fixed punitive policy toward the industry" which, according to the committee, "has so frightened capital that it has proved impossible to finance most of the needed construction."

Dollar values of electric utility construction during the years 1923 to 1937 were given as follows. The 1937 figure is based on an estimate by the Edison Electric Institute.

Year	Expenditure
1923	$794,000,000
1924	808,000,000
1925	846,000,000
1926	772,000,000
1927	794,000,000
1928	754,000,000
1929	853,000,000
1930	919,417,000
1931	586,740,000
1932	285,000,000
1933	$129,300,000
1934	147,654,000
1935	192,855,000
1936	275,000,000
1937	450,000,000

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Regional PWA Staff

(*Continued from page 732*)

Bournier, formerly assistant state engineer inspector for California; engineer, William C. Hammatt, formerly engineer in the state director's office, California.

Region No. 7 at Portland, Ore.: Assistant director, Eugene Hoffman, formerly state director of Washington; engineer, Ross A. Gridley, formerly engineer-inspector for Alaska.

In every case, except that of Omaha, the regional headquarters will take over the space formerly occupied in the city by the state PWA offices. All other state branch offices, except at Columbus and Harrisburg, will be closed.

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Tenth Muskingum Dam

Leesville Dam has been completed, the tenth to be finished of the fourteen dams in the program of the Muskingum Watershed Conservancy District. The dam is 1,695 ft. long and 62 ft. high. It was built at a cost of $500,000 by the Culbertson Construction Company.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Framing Economy

Sir: The article, "Stress Paths and Economical Framing," Sept. 2 issue p. 402 is based upon a misconception, too prevalent among engineers, that the design involving the least weight of steel is the most economical. Any analysis of a framing system should include such important factors as fabrication and erection. If the weight be reduced by "switch framing," does the design increase or complicate the shop work? What is the nature of the field operations? Does the lay-out involve more equipment or time?

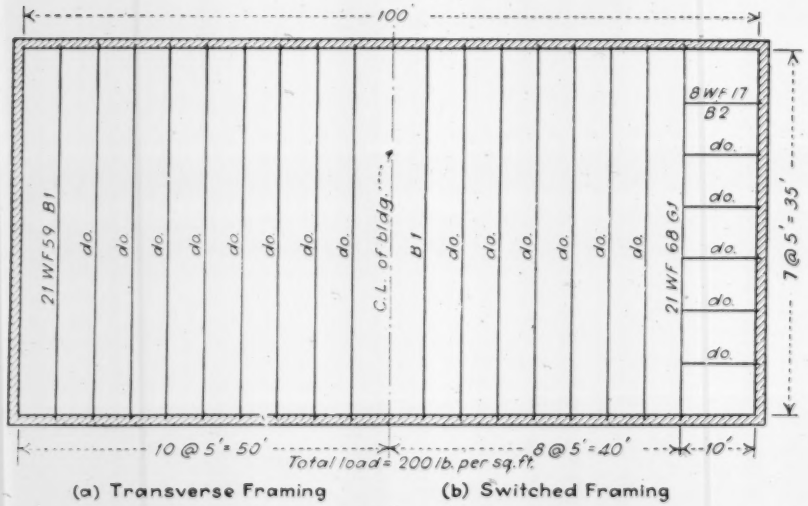
The author laments that "factors other than simple economy" influenced the adoption of viaduct design 3a, in preference to 3b, which the weighted length of stress path showed to be the lighter construction by twenty per cent. He fails to recognize the importance of these other factors. A casual inspection of design 3b reveals that twelve "built up" girders are required per span, whereas, design 3a has only three, rolled sections being used for stringers. Fabrication and erection comparisons are indispensible, if the economy be not shrouded in hazy guess-work. Significant cost data should be deduced from previous structures and applied to the component units of framing for a more reliable solution. Design for least weight, when the type of structure is determined, rarely presents a difficult problem to the engineer.

The author devotes considerable space to the recurring problem of framing a foundation opening. The writer, on the accompanying sketch, has indicated his design (Fig. 4) with minor revisions to conform more nearly to accepted practice of beam spacing; beams are seldom spaced a half panel from the wall. If the end wall will take the reactions of beam *B2* in design *b*, it should not be over-stressed from the half panel load from design *a*. The designs are thus placed on an equal basis.

A detailed estimate of design *b* was made. The extra cost involved was conservatively estimated, and included such operations as; shop drawing, punching *G1* and *B2*, shearing and punching connection angles, shop riveting angles to *B2*, shop assembly, hoisting into position and field riveting the switched framing.

The results are not startling. When the weight of the 10 ft. end panel is compared to two 5 ft. panels, a saving of 15% is evident in favor of the switched framing. However, the cost in place is only 3.4% less than the simple transverse framing. When the entire opening is considered, the weight saving is 4.1%, and the difference in erected costs amounts to less than 0.1%. Better delivery is obtained for the steel in design *4a*, which should be given preference. Simple transverse framing is definitely the more economical when encasement of steel is required.

Pittsburgh, Pa. ERNEST E. BERGER
September 7, 1937 Structural Engineer



(a) Transverse Framing (b) Switched Framing

How should the end panels be formed to obtain the greater economy?

Sir: Mr. Berger's comment is appreciated. Although the author agrees substantially with his dollars and cents analysis of the foundation opening problem the 8 in. 17 lb. beams appear considerable overweight, a 7 in. 15.3 lb. or even a 9 in. 13.4 lb. channel being sufficient. The heavy beam will increase the weight saving in the "switch framed" area to 25 per cent, which must be balanced against any additional fabrication cost.

Mr. Berger's comment on the alternate viaduct framing (Fig. 3) contains the implied suggestion that the different portions of the stress path be multiplied by a factor representing comparative fabrication cost. The author is glad to adopt this suggestion. If Mr. Berger will imagine his 35 ft. span increased to 120 ft., so that all members are built-up girders or constant depth trusses, it is possible he would find it advantageous to save 25 per cent in weight without additional fabrication cost. Also with equal depth trusses on the 120 ft. span he might be interested in the point at which to switch framing, in this case 41 per cent of 120 ft., or 50 ft.

The author had hoped for a more generalized and theoretical discussion. In presenting the original article he had hoped to open up the field and suggest some of the principles of what might be called a "science of framing"; to establish certain propositions which would guide the engineer in selecting an economical framing pattern. The principles established were, first, the necessity for a direct transmission of loads to support with a minimum of lateral deviation, and second, that the section modulus (resisting moment) of beams or girders within a very wide range are directly proportional to their depth and weight. The fact that an estimate accurate to within 3 per cent for the

section modulus of a 72 in. girder weighing 300 lb. can be made by direct proportion from the known modulus of a 10 in. or 12 in. wide-flange beam has astonished many engineers.

The author realizes he has not done the field justice but feels that the subject merits the attention of some of our more accomplished structural analysts.

New York, N. Y. GEORGE BOOSS, JR.
Oct. 25, 1937 Asst. Engr. (Designer)
N. Y. C. Board of Water Supply

Concrete Floor Units

Sir: In an article "Test of Precast Concrete Floor Units" (*ENR*, Sept. 23, 1937, p. 507), the captions for Figs. 1 and 4 were interchanged during the printing which perhaps will cause some confusion for the reader: the credit line "From Republic Fireproofing Corp." should refer to the drawing showing the one- and two-way slabs.

Also, in the table "Summaries of Results of Tests," the note "Average strength at 7 days 2,720 lb. per sq.in." refers to the rib concrete only.

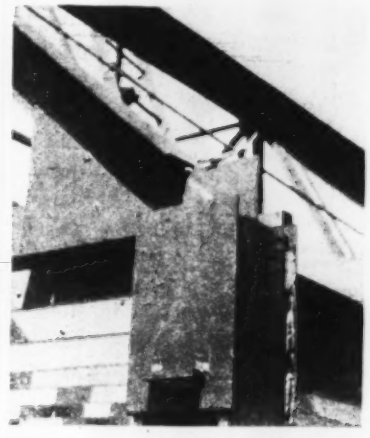
Cambridge, Mass. ADDISON F. HOLMES
Oct. 6, 1937

Erection Bolts in Welding

Sir: We have read with considerable interest Gilbert D. Fish's article (*ENR* on "Welding for New York Buildings". As consulting engineers, we have designed and supervised construction of over thirty large all-welded buildings and many small alterations.

Mr. Fish's statement that engineers find difficulty in doing the work as economically as riveted work because of the lack of published shop standards covering welding, accords with our own early experience when we found from our own office records that while we produced a more economical job for the owner, it actually cost us more money to design the welded job. Analyzing this condition, we found it was due to this lack of any standard of practice and the necessity of showing almost minute details on plans for the benefit of the fabricator's detailers. Accordingly we immediately set about getting out a set of standard details covering the amount of weld and type of connection required for every size of rolled steel beam.

On completion of this work, which we have kept up to date with the various changes in steel beam sections, we found that our costs of designing and drafting for the average welded steel frame immediately dropped to the same costs as designing riveted work. We further found that, with this information, the fabricating shops detailed the work with practically no error and for equivalent costs of detailing riveted work.



Typical erection seat for welded building erection. Seat angle, shop welded to the beam will engage this seat and no erection bolts will be required.

I believe that Mr. Fish's paragraph in which he states "that good judgment is needed in planning the number and arrangement of erection bolts and that no satisfactory substitute for erection bolts has been developed", is open to serious question. Our earliest welded jobs were done with erection bolts and, to hold a frame stiff enough for safety under erection conditions, it was necessary to use almost as many erection bolts as one would have required holes for riveting; fewer erection bolts had to be supplemented with a great many steel cable guys to hold the frame plumb. The result of either procedure increased the cost of a welded building job (except the factory type) above a similar riveted building.

The question of whether a welded job shall be used is generally settled by the owner's question as to what is the most economical construction to use, rivets or welding. Erection bolts make welding a more expensive job and that settles the question from the owner's viewpoint.

Several methods have been developed to eliminate the use of erection bolts. I can only speak from experience with our own method, which we have used successfully in twenty-six steel frames of all types which you described in *Engineering News-Record*, July 9, 1931, in an article by A. R. Ellis, now president of the Pittsburg Testing Laboratory. This method involves the use of special erection seats of drop forged medium grade steel or annealed cast steel which are shop welded to the member and engage clip angles and seat angles shop welded to the connecting member. This erection seat, described in Mr. Ellis' article, has permitted us to build welded multi-story buildings, both steel frame and the type shown in the article, at the same ton price erected in place as a riveted job. And due to the savings in tonnage developed by welded design against riveted design, the welded frames have been the more economical.

Many engineers and up-to-date fabricating plants are interested in welded building construction due probably to the fact that their experience prompts them to believe it has money saving possibilities. But the engineers are going to be upset to find that due to field bolting requirements, what looked like a saving or equal cost proposition as compared to riveting, will not develop from actual contractors' figures. In view of this, engineers should know that methods entirely eliminating field bolting have been developed and widely used in many successful welded buildings.

Baltimore, Maryland VAN RENSSELAER P. SANE
Sept. 29, 1937 Consulting Engineer

West Side Highway Steel

Sir: In looking over the article, "Reclaiming a River Front," appearing in the June 10th, 1937, Enginering News-Record, we note on page 769 the statement, "Track enclosure steel, 72nd to 83rd St., American Bridge Company."

We wish to call your attention to the fact that the Harris Structural Steel Co. furnished and erected the structural steel from 72nd to 76th St. That section was not among those built by American Bridge Co.

New York, N. Y. ALAN H. SPROUT
Oct. 18, 1937 Harris Structural Steel Co., Inc.

ENGINEERING NEWS-RECORD

Volume 119, Number 19

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NOVEMBER 4, 1937

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REGARDLESS OF ONE'S VIEWS on "yardsticks" for power rates, there is satisfaction in the fact that a start has been made toward fixing power rates at Bonneville. J. D. Ross, within a few weeks of his appointment as administrator, has stated that rates will be based on provision for amortization in the government's investment on the power facilities at Bonneville Dam in 40 years with 3½ per cent interest. There remain such questions as absorption of interest during construction and during the market-development period, payment of tax equivalents to local governments, and allocation of the cost of the dam lock and fishways between power and navigation uses. For more than two years all efforts to build a market for the power that will now be available within a few weeks have been of no avail because no one knew what the power would cost. Though about two years too late, the present action therefore is welcome. If decisions on the still open questions follow promptly, both the public and the potential power customers should soon know just how long the Bonneville yardstick is to be.

A Reservoir of Work

ONE EFFECT of the uncertainty as to what the federal government plans to do in the electric utility field appears in a statement just made by the Committee of Utility Executives. That body reports a deficit of nearly three billion dollars in public-utility construction accumulated over the past five years. In the 10-year period 1923-1932 inclusive the average expenditure on new construction by the electric utilities was $752,000,000, which included two depression years; in the past five years the average was only $239,000,000, which includes an estimate of $450,000,000 for 1937. All of this deferment of construction was not due to the anti-electric utility attitude of the federal government, but undoubtedly a large part of it is so chargeable. It constitutes a very large reservoir of privately financed construction that could and would be drawn on much more heavily if the government's power policies were sufficiently stabilized to permit the electric utilities to do some of the advance planning about which so much is heard these days. The hundreds of millions that the utilities should be spending would be just so much off the federal outlay for WPA and other forms of relief.

Making Headway

SANITATION PROGRESS in the largest city of the United States took a long-delayed step forward a few days ago when the Ward's Island sewage treatment plant was officially placed in use. This 190 m.g.d. activated sludge unit, first plant for complete treatment of sewage in New York City, represents partial culmination of efforts initiated more than three decades ago, when the Metropolitan Sewerage Commission was formed. The teachings of those early studies came to first fruition in 1935, when a modern partial treatment plant went into operation at Coney Island. Other plants are under construction or soon will be started, and the next decade should see the completion of 38 plants handling a billion gallons of sewage daily. Thus the $30,000,000 Ward's Island plant is more than a monument to engineering skill; it stands as evidence of an enlightened attitude on the part of the city toward the wellbeing of its citizens and of neighboring communities, and for this reason outranks many more spectacular works.

Too Often to the Well

ROAD-TAX DIVERSION in Massachusetts amounts to $34,750,000 over a period of five years. Since 1933 the Bay State has been one of the most persistent of states in grabbing the highway users' road-service fees and taxes for general state administration expenditures. Every year it has dipped into the till for millions of dollars. But the pitcher has gone to the well once too often. Retribution threatens at last: the Bureau of Public Roads, acting under mandate of the Hayden-Cartwright federal-aid act, has announced its purpose to reduce the state's 1938 federal-aid allotment as a penalty for continuous misuse of road funds. According to the federal law a penalty of over a million dollars is possible. Badly as Massachusetts' roads need this million dollars, it is a small penalty for five years of misappropriation—or even for the 1937 diversion of $6,600,000. Like some other states Massachusetts may elect to take the cut and keep its privilege of spending a much larger sum as it pleases. This is the weakness of the present federal-aid law as a punitive measure: it tries to stop looting by imposing a mild fine on the looter. Where the possibility of gain is large the looter pays his fine and goes cheerfully on with his thieving. When next the states appeal for road-building aid Congress may well consider that no sound theory of federal aid justifies the use of federal funds to replace state road money used for other purposes.

Construction Goes On

WHAT ARE THE PROSPECTS for construction in the immediate future? The question is asked every day in one form or another. Whoever is concerned with construction activity, be he engineer, contractor or manufacturer, looks at the prolonged summer slump in production and the disturbed state of the investment community, and is inclined to feel uncertain.

It is worth looking at the facts of today before consulting the prophets. The record shows that construction is moving forward at steady pace in every department. The summer sag, this year prolonged through September, is ended by an October contract record well abreast of the figures for the first half of the year, not only for the country as a whole but in each of its geographical subdivisions.

Construction by private enterprise in all forms recovered from the summer drop with a gain of nearly 50 per cent. The important fields of industrial construction and commercial building were equally prompt in this recovery. Gradual decline in some branches of local public works construction, mainly waterworks, at most reflects reluctance to change from the PWA system. Nowhere do the figures show evidence of general slowing to a lower rate of construction, and, since a healthy 10 per cent increase over last year's contract total is certain, gloom talk can come only from those who have clung too long to the vain hope of a construction boom.

Unquestionably many orders and commitments have been deferred; when uncertainties prevail, care in making commitments is no more than prudent. But despite the caution that has governed the operations of business and industry during the past three months the figures show that construction so far has marched on undisturbed. This record, coupled with the well-known fact that there are large unfilled needs for construction, gives little support to pessimism in appraising construction prospects.

Better Public Service

PERSONNEL PROBLEMS in local government service were given a well-deserved airing at the recent meeting of the American Public Works Association. Condemning traditional civil service as stagnating, and urging that century-old ideas and practices be overhauled, the association went on record as favoring the adoption of the merit system for all governmental employees.

The civil service was originally designed to eliminate the spoils system. In theory it was sound, in practice it has been subject to abuses. The principal weakness has been the absence of a penalty for incompetence. Besides, since it furnished security to those in the service once they had received appointment, it abetted insubordination and arrogance. And not the least of its weaknesses is the "local boy" complex.

The merit system has for its objective to preserve the worthwhile features of civil service while eliminating its weaknesses. It provides for competitive examinations, establishment of adequate compensation classifications and salary increases, removal of incompetents, and development of the career-service concept.

Adoption of a system such as this in lieu of present methods of personnel administration would not only attract desirable men to the public service but would also hold them. At present the field of governmental service is not held in high regard, but with the increasing responsibilities of governmental functions it becomes daily more important to raise the efficiency of the service. The first and greatest step to this end is introduction of an improved personnel policy through the merit system.

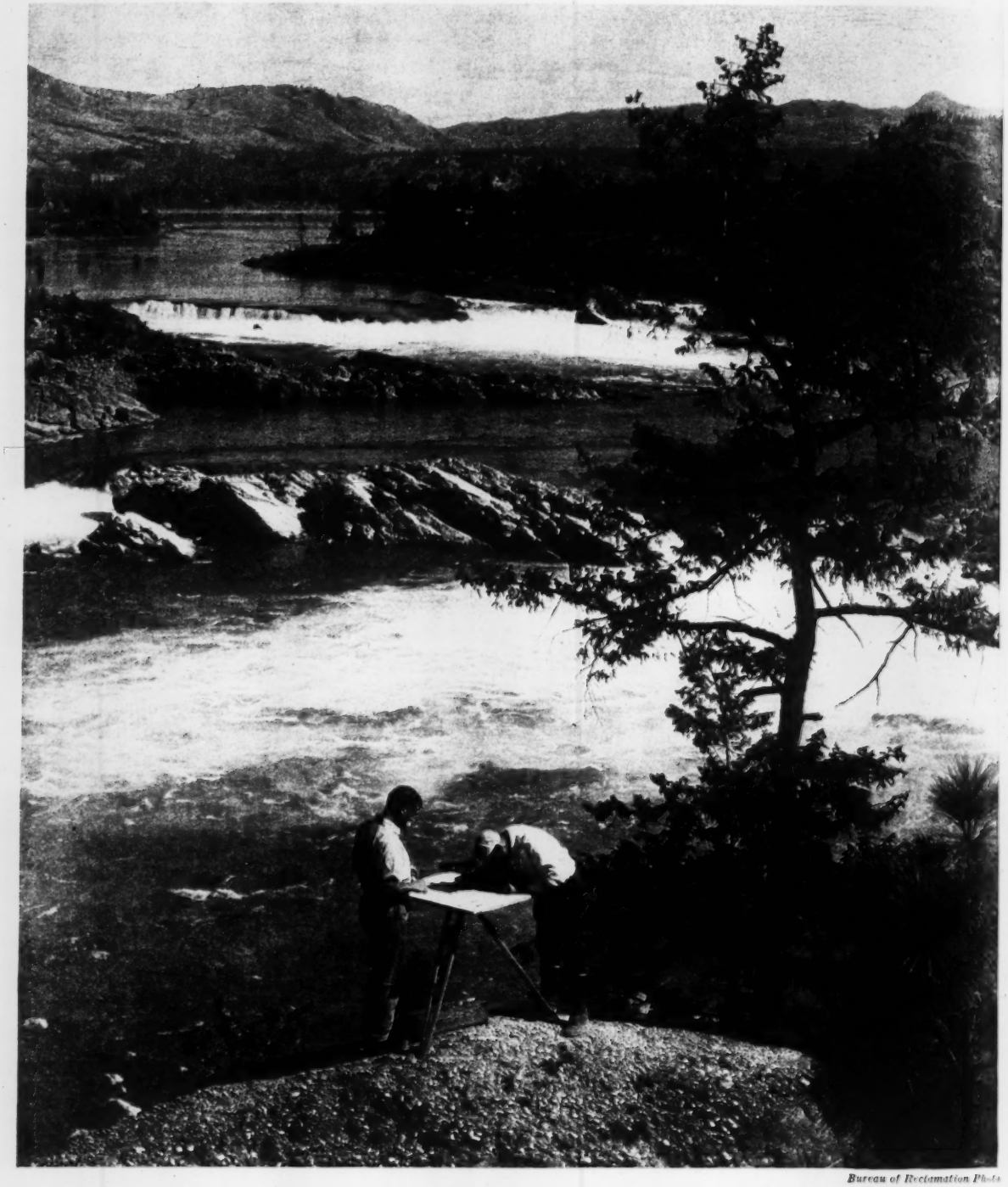
Master Workmen

THE FOUNDATION WORK for the New York City express highway described in this issue is a notable example of construction skill and resourcefulness. Acclaim often rewards the foundation builder's more spectacular operations—deep-water piers for the bay bridges at San Francisco, or foundations sunk in the Mississippi's deep mud. There is no similar appeal in the long series of cylinder-sinking and pile-driving operations that placed New York's water-front superhighway on a bearing of solid rock, a mere succession of petty and irritating difficulties that have to be overcome. Yet this work too merits admiration.

The great interest of the work lies in the diversified ways in which ingenuity was applied. No new and strange equipment was brought into service. All of the burden rested squarely on the shoulders of the constructor. At every hour he was called upon to devise a method to overcome a new obstacle. His only resource was mastery of his art and instant readiness to apply its resources.

Mere description hardly does justice to the obstacles to excavation and penetration offered by the made land that borders the Hudson River water front at New York city. Nature never excelled this man-made covering in presenting hindrances to construction of solid foundations at moderate depths. Two factors of success besides the builder's skill were the steel pipe pile and the mammoth device for boring down large steel cylinders fitted with toothed cutting edges. Both pipe piles and boring cylinders demonstrated through their performance on this job that they are entitled to high rank among the tools of the construction engineer.

PICTURES IN THE NEWS



Bureau of Reclamation Photo

KETTLE FALLS ON THE COLUMBIA RIVER about 110 miles above Grand Coulee Dam. A plane-table party at work in the area that will be affected by the dam's storage. The Grand Coulee reservoir will have a capacity of almost ten million acre-feet and will extend up the Columbia River 151 miles to the Canadian border.

Sinking Caissons in Debris Fill

Filled shoreline of buried bulkheads, dumped rock and debris penetrated by 353 caissons and 143 sheeted pits for New York

ONE OF THE MOST NOTABLE foundation construction operations of all time has been going on for seven years in building New York City's express highways along the Hudson River water front. The exceptional interest lies in the number of separate foundations and the bad underground conditions. No single foundation is imposingly large or deep or spectacular in other conventional respects, but the work has involved sinking 353 steel caissons 4 to 10 ft. in diameter; sinking 143 sheeted pits for rectangular piers, and driving, evacuating and filling with concrete over 130 mi. of steel pipe piles. Combined with formidable underground materials this volume of work rates comparable rank as a construction task with many of the great bridge substructures built in the last seven years.

The express highway in itself is remarkable. In the simplest terms it is a wide paved road extending some 20 mi. from the lower part of Manhattan Island along the Hudson River, over the Harlem River and through Bronx Borough to the north city limits of New York. In all this length there is not a grade crossing and all traffic enters and leaves its directional stream by side ramps. Parts of the highway are elevated steel viaducts, parts through parks are at grade, a part is on the roof of a steel and concrete box inside of which runs a railway and a part crosses the Harlem River on the longest (800 ft.) steel fixed-arch span in the world (*ENR*, Aug. 13 and Nov. 12, 1936). The pile, caisson and other substructures previously enumerated carry the steel viaduct, concrete box, ramp retaining walls and other run-of-route structures. A more complete description will be found in *Engineering News-Record*, June 10, 1937.

To understand the foundation problem the reader has to be taken o the location and below the surface. The design was simple: Footings and piers on piles and caissons, piers on rock, walls on piles embrace about all the design problems. The real problem was construction: Specifically how to sink caissons and pits and how to drive piles. Here is where location and underground conditions play a part. They are worth some careful consideration.

Geologically the west side of Manhattan Island is the earth-buried lip of a rock gorge in which flows the Hudson River. At the southern end of the island the earth covers the rock to depths of 50 to 100 ft.; at the north end the rock lip rises to about 100 ft. above the river level. At several points from south to north the rock lip is cut through by lateral gorges which are also buried. The express highway crosses these earth-filled lateral gorges. At the first of these gorges just south of Canal St. the earth fill is 110 ft. deep; at the second, at 26th St., a pile was driven 185 ft. to reach rock; one at 40th St., and one at 59th St. are about 100 ft. deep to rock; one at 125th St. is almost as deep as that at 26th St., and another at 145th St. is about 90 feet deep.

Origins of overburden

The earth covering of the rock through which pile driving and caisson sinking had to be carried is of two origins. First of course was the soil deposited by nature through the ages, but superimposed on this is filled material placed by man in extending the shore line as land was wanted for harbor purposes. It is this work of man that put the misery in the foundation construction. First the building out of the shore line brings the present road line in many places outshore of the original river edge and second, the materials of the fills are of many kinds and origins.

Back probably before the revolution, men began building bulkheads of cribbing filled with stone at which to dock their sailing ships. As there was plenty of room in the river, these structures naturally thrust out from the shore into deep water. Sediment collects along bulkheads, however, and slips silt up; barges sink against docks and go down in

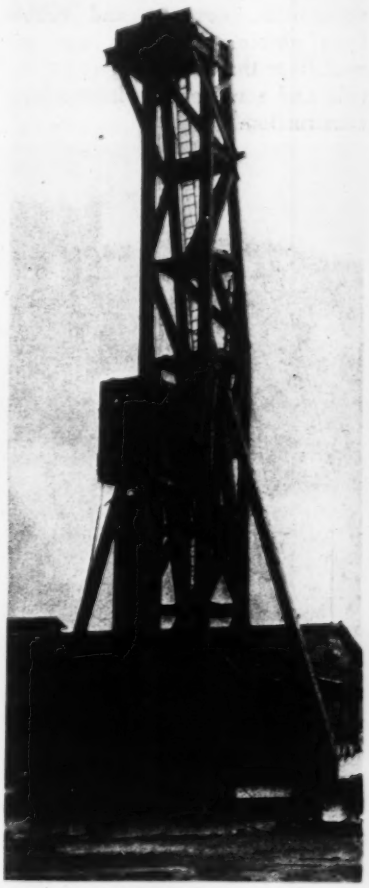


Fig. 1. Shells with a toothed-edged bottom and rotated bodily like a drill cut successfully through earth, rockfill and solid concrete.

the mud, and as more land is always wanted, again the cheapest thing to do was to build new bulkheads out a little farther and fill over the old ones. Gradually, a solid line of bulkheads grew, from the Battery to Canal St. Reconstruction of the island from maps of revolutionary times show the shore line in this section to have been pushed out several hundred feet. In the course of time the line of bulkheads crept up the river until finally halted by the establishment of Riverside Park at 72nd St.

Where sand or gravel covered the original rock at the shore line, these cribs still stand where placed, extending about 20 ft. below water; at other points, where they were founded in silt or mud, they have sunk of their own weight till they are now only a few feet above rock. In the last few decades other classes of fill have made their appearance along the Hudson. Park areas and railroad yards began to be extended with brick, concrete and rubbish from obsolete buildings, and with rock from the Catskill Aqueduct tunnels and some of the later subway construction.

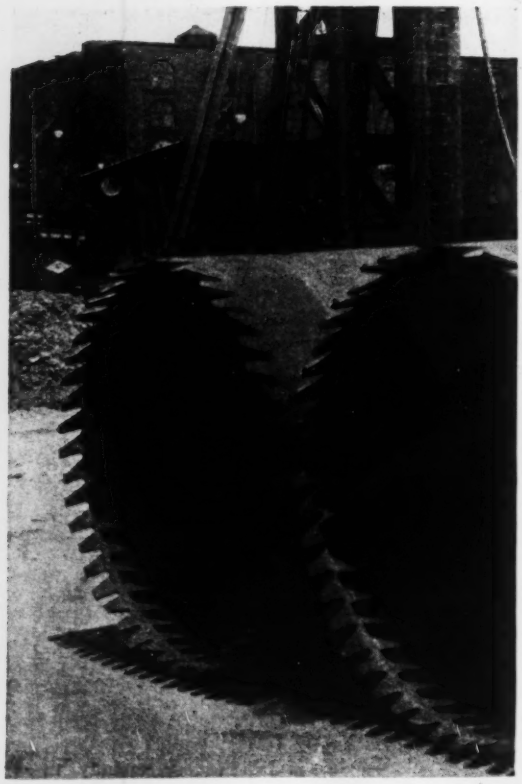


Fig. 2. Bit ends of shells sunk by rotating like a drill.

Few situations more distressing for sinking small caissons and driving piles can be thought of than those described. How they were met in caisson sinking is told in the article that follows. A second article will describe the methods of driving some 130 mi. of piles.

Diversity ruled the work

New York City's West Side Express Highway has required for its construction probably the largest and certainly the most diverse small-caisson job ever undertaken for a single purpose. Extending from August, 1930, when the first caissons were started between the 59th and 72d Sts. by the boring method, to late in the current year, when the last that have been let to contract will be sunk by the compressed air method adjacent to the Hudson Tubes downtown, this work has already extended over seven years. When current construction is completed 353 circular steel caissons 4 to 10 ft. in diameter and 143 sheeted pits for piers will have been sunk, an average of over 50 ft. deep, but some of them going down over 100 ft.

Caissons and piers have been put down by every known means of sinking except open wet dredging and freezing. They have been put down by three new methods, two of which had just been invented and used once previously, and one of which, while it was a combination of known methods, applied them to conditions where it would have been thought they were unworkable, and produced some startling results. Sinking has run to more than 100 ft. in depth. It has encountered old bulkheads, stone-filled cribbing, rubble-masonry sea-walls 40 ft. thick, concrete mats, manholes and sunken barges. Perhaps worst of all, it has penetrated on two contracts large quantities of Fordham gneiss and Manhattan schist. Ordinarily when these rocks are struck, it is time to stop and call it a foundation. In this case, far from being in original position, the rock has come from the subway, aqueduct and foundation excavations, and has been dumped along the margin of the Hudson River in chunks ranging from paving-stone to ten-ton size that have wedged together into almost the solidity of masonry.

Unforeseen difficulties

Steel caisson shells have been partly collapsed by mud waves and corrugated by the sharp point of a rolling boulder while being spun down to rock. A high-pressure air pocket that blew the gaskets out of one caisson was encountered. Caissons have been bottomed in free air nearly 90 ft. below low tide on sloping rock by means of lagging, and the work handled so fast that they were successfully sealed before the brief pumping operation could start runs in surrounding harbor mud. Caissons have been driven down by pile hammers, and spun down by a 900-hp. rig that turned the whole shell into a drill. Caissons have been lowered into pre-cut holes, and into wells reaching below harbor-bottom, laboriously cleared of cribbing by divers. Caissons have landed on a sunken cliff-face buried in riprap, with cutting edges standing in almost clear water, and have been sealed by divers. And caissons have been sunk, bottomed, put through obstructions or trued after landing out of plumb and out of shape by the old, reliable compressed-air method. Such small, deep shells, of course, could not have been held in line through obstructions by wet dredging. And freezing, the only other sinking method ever used, was passed up by the five contractors concerned, probably because it would have cost more to put down ammonia pipes in most of the locations than to sink the whole caisson.

How was the work done? First it was a contractor's job; contractors selected and devised the equipment and working methods. This developed variety which is the most interesting feature of the operation. These are summarized in the accompanying table.

In August, 1930, sinking began on the first lot of 147 caissons on New

York Central R. R. property between 59th and 72d streets. The contractors employed as far as possible a new method of emulsifying the soil with a jet-equipped boring bit just larger than the size of the caisson, and then lowering the shell sections into the hole. The scheme had been used successfully, and for the first time, a short while before in constructing piers for the Hackensack River bridge of the Pennsylvania R. R., described in *Engineering News-Record* Sept. 30, 1930. Instead of the 3- and 4-arm bits with broad cutting blades employed in the mud of the Jersey meadows, 3-arm bits with a greater number of narrower blades set on each arm were used, as being better adapted to a soil where rock might be encountered. As a matter of fact, it was soon found that one or two fair-sized stones would be picked up by the bit and ride on down, but by the time half a dozen had been collected the boring was stopped. It was then necessary to withdraw the bit, lower a section of shell to the bottom to permit dredging with safety to the sides of the hole, and fish the boulders out with an orangepeel. When this had been done, the shell would be lifted out and the bit started again. If the bit did not travel more than 5 ft. without clearing out rock, it paid to move the machine off the hole, insert the shell and finish sinking by other means.

Fourteen caissons adjacent to an elevator and other structures were sunk from the start by compressed air. Some of these were carried through timber cribbing and other obstructions by the pneumatic process. Four more, which encountered heavy obstructions, were successfully sunk by hand in the open. Thirteen caissons which landed on rock-filled cribbing, extending in some cases almost to the bottom, were lowered into holes sunk through the obstructions in 2-ft. oversize shells by divers. By using the oversize shells, serious risk of displacement in passing through the cribbing was avoided. Oversize shells were also used at the top of several of the difficult holes to allow sheeting to be driven. In some cases where the shell had been sunk down close to rock before it stuck entirely, wood sheeting could be used. In others, 7-in. interlocking steel sheeting was driven. In some deep holes where it was not advisable to pull the shell and sink an oversize casing, sinking was continued to rock below the cutting edge by inserting lining rings as the men went down.

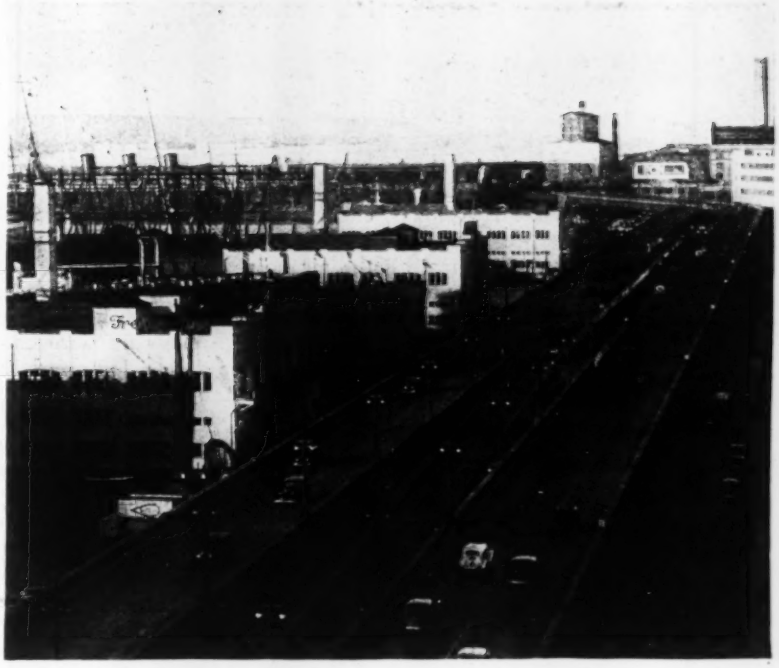


Fig. 3. Part of the completed West Side Highway looking north along the Hudson riverfront. Note the access ramps.

Altogether, the auger was used on 116 of the caissons, only 11 being carried clear to rock by the process. Turned through a shaft of 10-in. extra-heavy pipe in a 20-ton caterpillar-mounted drilling machine, this tool cut its way through 60 per cent of the total distance of sinking. In 55 of the holes the machine bored to within 10 ft. of rock; on the remaining 50 it was stopped from 11 to 34 ft. above bottom. The process left the hole filled with a semi-liquid material which was taken out, after inserting the shell, with bottom-trap well buckets. Any stone or hard material was dredged. Shells lowered to the depth reached by the auger and cleaned out were driven the rest of the way, for the most part, by a pile hammer of the largest size, seated on an H-beam across the caisson at the top.

The shells themselves were $\frac{1}{2}$- and $\frac{3}{8}$-in. thick, depending on the diameter of the caisson. They were reinforced with 8-in. channel hoops, spaced closer as the depth increased. The bottom section was further reinforced with a 2-ft. deep band of $\frac{3}{8}$-in. steel.

By these methods 79 caissons of 5-ft., 47 of 6-ft. and 21 of 7-ft. diameter were sunk 26 to 102 ft. in 11 months.

Heavy pumping in sheeted pits

The following year, starting in January, 1931, a second contractor put in 144 square and rectangular piers, one of them resting on two 7-ft. diameter caissons with $\frac{1}{4}$-in steel shells. The piers ran from $3\frac{3}{4}$ to 9 ft. squares, and from 8x21 ft. to 6x25 ft. rectangles. One of the caissons went 60 ft. below low tide, and one of the piers to 56 ft. The average depth was —30 ft., or 46 ft. below subgrade in the New York Central yard which now covers the site.

Fanning south and into the river below 76th St., a large rock fill had been made with excavation from the Eighth Ave. subway. Between the toe of the fill and 72d St. a 15-ft. mud wave had been pushed up. Both 4-in. wood sheeting and interlocking steel sheeting were used on this section. The excavation was done with $\frac{3}{4}$-yd. orangepeel buckets and by hand. A foot or two of hardpan overlay the rock. Water was the most serious difficulty to be overcome, as the stone fill practically let the river into the

site, and the harbor mud encountered below, when saturated, flowed into the pits as fast as it could be dug out. The contractor met the situation by placing a 6-in. and an 8-in. centrifugal pump in all the pits in the rock-fill section except a few at a time on which sinking was in progress. Ground water was finally lowered in the area until pits could be bottomed and sealed dry. As many as 16 pumps were working in this section at one time. The pits in the mud area were drained until the mud was dry enough to stand, with one of the largest piers at the south river corner being pumped continuously with two 8-in. centrifugals. The pair of 7-ft. shells, which carried the outside pier at 72d St., went down most of the way of their own weight, but were driven to some extent with a pile hammer.

Open sinking in harbor mud

The same year a third contractor, starting the section from 38th to 46th Sts. in October, 1932, proved that it was entirely possible to sink much deeper caissons with open pumping in unstable materials, and bottom and seal them on rock, provided one moved fast enough. The elements of the method were not entirely new but the results were. Pulling boulders in under a cutting edge in mud, close to open water, and driving the shell on down before a run could start might have sounded like a hare-brained idea before this contract proved it could be done. Yet the third largest total of 105 footings went down entirely in the open without a single serious run, and with only a few cases of boiling material, promptly corrected each time by immediately driving the shell.

One of the elements of the method was an individual air hoist on a trolley for each shell. This dumped material independently of trucks, so the men at the bottom always had hoisting service, and could sink without stopping. If an open shell, pumped to the bottom, were allowed to stand at the same elevation a day or more in such location as that at the head of the old 39th St. slip, runs might start which would make further sinking in the open impossible. Another element which contributed to a method that, as a whole, deserves to be considered as a new development in sinking, was the pumping. A type of pump which would keep working against high head on a small quantity of water had recently come on the market, and without it, tackling the work in this way would have been much more difficult.

Where no obstructions were encountered it was easily possible to sink these shells 10 ft. an hour with the air hoist and a 6-cu.ft. bucket. Most of the way excavation could be carried right down to the cutting edge. Two pile hammers were employed to keep up driving speed as the shells neared bottom. Where uneven rock was encountered, wood lagging, retained by an angle ring inside the cutting edge, was driven around the low side. By immediately cleaning off, stepping and concreting, not one bottom was lost. No trouble with displacement of the lagging was experienced, though some of the shells landed in mud on rock sloping at almost 45 deg.

Fig. 4. Steel shells were driven by pile hammers striking H-beam laid across the driving head after a hole had been bored by a jet-auger.

It is possible that the next time the method is tried under similar conditions, heavier shells, or shells with inside reinforcing, will be selected.

Two large crawler cranes and three smaller ones were used on this contract to handle shells, head rigs, muck and hammers. A total of 23 4-ft., 36 4½-ft., 38 5-ft. and 8 5½-ft. caissons were sunk to depths varying from a few feet to 89 ft. below low tide, those in the west line below 40th St. being almost at the edge of the water at that time. The average depth was 46 ft. The shells used were ⅜ in. thick, with butt-welded joints between sections. The sections were 30 ft. long, and in some cases, where no obstructions were met, an entire section was sunk in 2 hr.

Some large rocks, dumped from subway excavations, had to be blasted. The largest had travelled all the way to the bottom in the harbor mud, as contrasted with the behavior of some of the rock fill along Riverside Drive, which was found to be still floating some distance above bed rock. Where exposed in excavating, these chunks were mudcapped. Where struck by the cutting edge in advance of excavation, some of them were shot by placing a light charge against them through a 3-in. pipe driven to the boulder and withdrawn before firing.

Fifty caissons sunk in month

The next caisson section of the express highway to be built holds the speed record for the entire project, as fifty 4-, 4½- and 5-ft. caissons were sunk 33 to 72 ft. between May 1 and May 28, 1936. It extended from 46th to 59th Sts., and the work was done with the rotating machine designed by J. J. Montee, which was first used on the foundations for the new Federal Building in New York City, described in *Engineering News-Record* for July 11, 1935, p. 37. This machine, which has been improved since the Federal Building was constructed, now carries a total of 900 hp., and a 65-ft. length of shell can be inserted under the rotating head, which can turn cylinders up to 12 ft.

in diameter. Its mounting has been changed from the typical land pile driver mounting on rollers to four large casters with double-flanged wheels, which can be swivelled so the machine can roll along a girder-beam track either in line with a row of caissons or parallel to it.

On the section between 46th and 59th Sts., the machine operated $\frac{3}{8}$-in. shells with a $\frac{3}{4}$-in. cutting edge, carrying saw teeth set to cut a $1\frac{1}{2}$-in. groove. The teeth were edged with tungsten carbide, welded on at the job. While being rotated, the cylinder, sealed at the top by the driving head, is kept full of water at city pressure, and a 150-lb. jet, discharging at a slight angle 30 in. above the cutting edge, is used. In anything but large rocks and timber most of the material is swept up outside the shell by this flow and carried off. It has been found that pumping this liquid back through the jet increases cutting speed, and consequently the flow from the shell is run to the sump of the jet pump. This is hard on the pump, but a type of pump has been selected which runs the rig without delays. When pump replacements are needed, they can be made while the setup is being changed. Timbers and rocks which remain inside the shell after it has landed are found to have been greatly worn and ground down, possibly to less than half original size. They are removed with a small orangepeel, handled by a crane, or by men, using a timber head frame and a gasoline hoist.

The shells, spun at 5 or 6 r.p.m., cut rock readily. Unless rock is deeper than expected, or has a marked slope, sinking is continued until a groove is cut into it all around the shell. Under these circumstances it is usually easy to clean off the bottom and seal the caisson in the open. The pump is suspended from a crane, and hoisted out of the way of concreting as soon as the bottom is dry. Commercial concrete has been used.

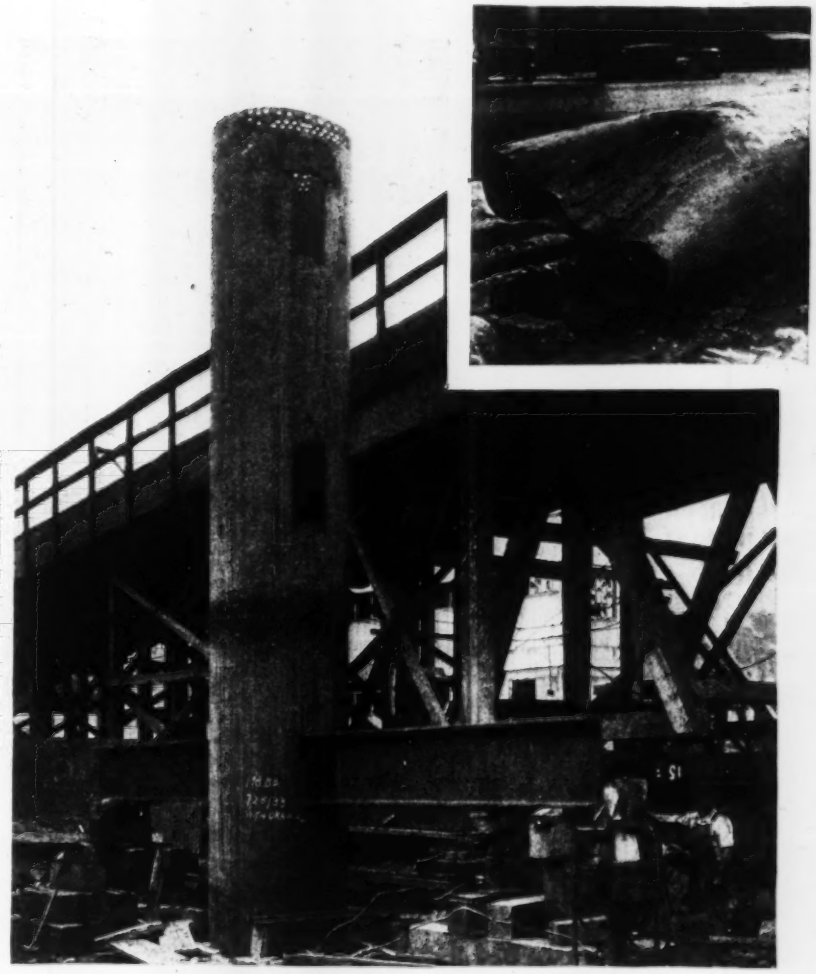


Fig. 5. Obstructions frequently necessitated withdrawal of shells by use of jacks. Insert shows damage to one shell which had to be withdrawn.

Stone fill makes hard cutting

The same contractor was engaged this summer in boring caissons with the same equipment through stone fill, including an old dry-masonry breakwater, placed along the shore of the Hudson below 146th St. some time ago. Sinking at this point brings up interesting developments in the method. It was expected that most of the stone would be found in the west, or river line of caissons. This line is on the old stone bulkhead, which retains the fill for the New York Central's yard at this point. These shells, therefore, were made $\frac{3}{4}$ in. thick with a bottom section, carrying the teeth, $1\frac{1}{2}$ in. thick. The shells for the east line were made only $\frac{1}{2}$ in. thick with a 1-in. cutting edge, but this was heavier than the metal used below 59th St., where some difficult ground had been drilled.

It was expected that the east line of caissons, begun about June 15 last, would give little trouble in being spun down to rock at one operation. But a single drill hole at the center of each location may not tell the story in a mud-pudding filled with plums of subway rock; it may miss most of the big rocks. The machine was lined up to back off the caissons on this row. It was planned to turn sidewise for the outside row, except at the upper end where an old concrete freight platform was in the way. In this way if the shell became too full of boulders on the way down, the rig could move to the next and then move back after the rock had been dredged out.

When sinking was started on the inside line, it was soon found that the stone had spread pretty well under that side also. The machine backed off several of these shells to allow dredging to remove the inside friction, and eventually was turned sidewise for this row as well. The time lost, however, eliminated any chances of surpassing the sinking record made below 59th Street.

In addition to increasing the thick-

CONTRACTORS, VOLUMES AND CONTRACT PRICES OF CAISSON AND PIER WORK ON NEW YORK EXPRESS HIGHWAY

Section	Cedar St. to Canal St.	38th St. to 46th St.	46th St. to 59th St.	59th St. to 72nd St.	72nd St. to 79th St.	135th St. to 146th St.
Contractor	Poirier & McLane	Necaro Co.	Geo. J. Atwell	Senior & Palmer	H. H. Sherwin	Geo. J. Atwell
Number of Caissons	17	105	50	147	2	32
Number of Piers	.....	.....	.....	.....	143	.....
Average Depth, ft.	75	46	40	61	46	80
Maximum Depth, ft	97	94	72	102	76	90
Total Footage	1,200	4,857	2,000	9,100	6,614	2,700
Concrete Yardage	1,650	3,300	1,250	8,300	5,800	1,850
Bid	$115,000	.....	$100,000a	$675,000	$612,000	$344,000b
Final	.....	$190,000	.....	$750,000	.....	.....

a Estimated for caisson work on unit prices
b Bid on entire contract, but not including sewer contract
c Bid on entire contract

ness of the shells and cutting edges, after a 1-in. tooth had been recovered cut through at the base by side friction, the contractor began coating the entire surface of the teeth with tungsten carbide welding. The teeth developed for cutting this wedged rock have a sloping edge and a vertical edge. The shells are spun against the vertical edge in ordinary material, and are reversed and spun against the sloping edge in the rock fill, considerably improving cutting speed and greatly reducing the chattering produced by rotating the other way. In other types of obstruction, the cutting edge clears a circle slightly wider than the shell, which spins free in mud and water. In the loosely-packed rock fill, on the other hand, stones are liable to drop and wedge after the cutting edge has passed through them, producing considerable friction. In one case, what was probably the hard point of a very large chunk neatly corrugated one of the ½-in. shells for some distance near the top. Such corrugating in ½-in. metal affords a good illustration of the machine's power output.

As was to be expected, the shells being sunk in the 40-ft.-thick old masonry wall went down faster and developed less skin friction than those in the first row. The tight dry masonry held the shape of the hole cut through it, while the loose rock, which had wandered off to the east and sunk deep in the mud, did not, and was still present in force, producing a deep filling of stone inside several of the shells.

Most of the shells in the upper contract could be assembled complete under the rotating head. Those in the outer row which could not are in two sections, butt welded. Rock varies from 55 to 90 ft. down, 40 ft. or more of harbor mud having been penetrated under the old wall.

A new development has been brought about in sealing the caissons on the upper contract. The river washes the face of the stone bulkhead, and water penetrates the site freely. The rock, as in other sections along Riverside Drive, has a steep, uneven slope to the river that might be described as almost a buried cliff face. It has been found seamed, and has varied 5 ft. at the cutting edge from the elevation at which it was struck by the boring in the center. Under the circumstances, a considerable flow of water had to be handled when most of these caissons were pumped out. To shut this off for sealing the caisson, divers have been used. The diver, after the shell has been allowed to fill with water, places a sand bag ring around inside the cutting edge. Sometimes he sends up a few pails full of mud and sand to clear for the bags. He then goes around between the bags and the shell with the nozzle of a grout pipe, until the space around and under the cutting edge is filled. When this cement has set the shell can be pumped dry, the bottom prepared and the seal placed at leisure.

The drilling machine makes little of ordinary obstructions which do not produce a sufficient volume of hard materials to fill up a large portion of the shell on the inside. Boulders, concrete and timbers are cut through rapidly at 6 to 7 r.p.m., and sinking in ordinary ground at 3 or 4 r.p.m. is very fast. At 55th St., where the marginal way was widened by cutting off the end of a city block and demolishing an old incinerator, a reinforced concrete mat 18 in. thick was left some distance below the street. It would have been easy to break holes with air hammers for the six caissons which fell on top of this mat, but it was actually much cheaper to drill through it.

On the earlier contract almost two caissons a day were sunk. On the second, owing to the unusual amount of rock handled by dredging, plans called for a much slower speed.

The section below Canal St., foundations for which are being constructed this year, will require the largest circular caissons used. These are two of 10-ft. and two of 9-ft. diameter carrying a long span at Canal St. where the highway crosses the Holland Tunnel. Four 5½-ft. caissons and a 5-ft. caisson are to be sunk in the same location. Borings show rock at —82 to —91 ft. and the surface of the street is about plus 6 at this point. Air was put on at Canal St. Aug. 1 last. When these caissons have been sunk, the plant will be transferred to Fulton and Cortlandt streets, where 8 more caissons are required for footings adjacent to the downtown Hudson Tubes. These are 5½-ft. diameter, and rock at this point lies between —46 and —56 ft., datum again being 6 ft. below the pavement. Pile driving between these sections on the same contract has indicated that the caissons will penetrate a considerable thickness of hardpan above rock, as the thick bed of gravel under this section of the water front has been found almost in the condition of hardpan. The outside caissons are also expected to strike the old stone-filled crib bulkhead which has been encountered elsewhere. Compressed air is being used to avoid all possibility of displacement of material around the river tunnels. Cranes are being employed to serve the caissons.

The accompanying table shows the location, principal quantities, approximate contract cost and the contractors for the six sections. Those below 59th St. have been built for the city of New York, Bureau of Highways, under the Borough President of Manhattan. Clifford M. Pinkney, chief engineer of the bureau, has supervised their design and construction. The section from 59th to 72d St. was built for the New York Central Ry. for which J. W. Pfau is chief engineer. On the section from 72d to 79th Sts., also built for the New York Central, McKim, Meade & White were consultants, while on the section from 135th to 146th Sts., Madigan and Hyland, E. H. Praeger chief engineer, have been associated with Mr. Pfau's office in handling the engineering work.

Contract Delays and Interferences

by GEORGE A. KING AND GEORGE R. SHIELDS
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What courts have decided and the rules to follow when contract work is increased in cost by delays of government agents

THE STANDARD FORM of government contract for construction provides that if the contractor refuses or fails to prosecute the work, or any part thereof, with such diligence as will insure its completion within the specified time, or fails to complete the work within such time, the government may, by written notice to the contractor, terminate his right to proceed with the work, or such part of it as to which there has been delay. In the event of termination it is provided that the government may take over the work and prosecute it to completion by contract or otherwise, and the contractor and his sureties shall be liable to the government for any excess cost occasioned the government thereby. If the contractor's right to proceed is terminated, the government may take possession of and utilize such materials, appliances and plant as may be on the site for the completion of the work.

These provisions define only the duty of the contractor; it is assumed that the officers of the government will be diligent in performing their part in cooperating to complete the work. There is, however, a correlative duty of the government to do all that is necessary to expedite the construction; this is well defined by a recent decision of the Court of Claims as follows:

> The contract work that plaintiff was engaged in, necessitated some degree of cooperation upon the part of the public works officer. This meant not merely the performance by the public works officer of those obligations specifically enumerated in the contract, together with abstention from all interference with plaintiff's work, but required enough activity on his part at least to make possible the advancement of the work at the agreed rate. The public works officer had something more to do than simply observe the letter of the contract. It is apparent that he misconceived his relation to the contract work. Genuine cooperation on his part we find utterly lacking. His failure to permit inspection of piling at the wharf is an illustration of his misconception of the duties devolving upon him. Plaintiff, under yard rules, had to take delivery at the wharf instead of at the site. There is no good reason, as we read the record, why the public works officer could not have caused full, if not final, inspection to be made at the wharf, thus obviating the waste of time and money incident to carriage between site and wharf of piles, which the inspector saw fit to reject. This unbusinesslike method of carrying on was prevalent throughout the contract period. Where delays in the completion of the contract are caused by both parties to the contract, and the period for completing the work has thereby been extended beyond the time originally fixed, the obligation to pay liquidated damages is annulled and cannot be revived, and any recovery for delays must be based on the actual loss sustained.

A failure by the government to do its part toward the performance of the work may occur either at the beginning, during the progress or at the end of the work.

Delay in beginning

There is very commonly a contract obligation on the government to do something preliminary to the commencement of work by the contractor; an example is the obligation to furnish the site and sometimes also to clear the site. In a recent case, the contractor in preparing to bid for the construction of a public building, visited the site and was informed by the officer in charge that it would be cleared by the first of July following but instead of being cleared, by that time, it was not cleared until eight or ten months later. This statement of the officer in charge was held to be an agreement binding upon the government and the contractor to be entitled to recover all damages caused by delay in clearing.

In an early and very thoroughly considered case decided in 1873, the contractors after entering into a contract for the erection of a building at an army fort, made all necessary arrangements for carrying out the contract, expended money, contracted liabilities and abandoned all other undertakings to accomplish this purpose. Before beginning work they were notified by the engineer officer in charge to suspend work and not to resume until ordered. They protested against this suspension and stated that they had at great expense prepared to fulfill the contract and would expect indemnity for the loss and injury. Three months later they were ordered to resume and did resume and they satisfactorily completed the work under the contract. The delay caused by the suspension pushed the execution of the contract into a more inclement season, when it was more difficult to perform the work, and when the cost of material, the wages of labor, freight, etc., were much higher than they were when the work was suspended. The contractors were held to be entitled to all damages caused by this suspension, including the value of lumber washed away or stolen during the period of suspension.

In one case a building was to be constructed of marble and the contractor made a contract with a solvent marble company for all the marble required by the contract. The government failed to furnish the site in time. In the meanwhile, the marble company failed and the contractor was compelled to procure marble elsewhere at a higher price, and was thus involved in heavy loss. For all such loss the government was held responsible.

Where a contract is made for the construction of concrete walks and steps and provides that all grades and walk locations shall be set and staked by the government and the

contractor shall not proceed with the work prior to the establishment of grades, the failure of the government timely and systematically to lay the grades and set the stakes, thus delaying the contractor in beginning the work and consequently postponing the completion of its performance within the contract time gives rise to a valid claim for damages on the part of the contractor.

Where the government agrees to furnish the necessary foundations for structural framework to be erected by the contractor, and neglects to furnish the foundations in sufficient time to enable the contractor to proceed at the agreed rate, such delay is unauthorized and must be compensated by the government by the allowance of all expenses incurred by the contractor due to the delay.

Delays during progress

Cases often occur in which the government delays the contractor, both in the beginning and in the subsequent performance of the work.

In a contract for work at a navy yard it was provided that the exact locations should be determined by the officer in charge, and also that the contractors should be allowed reasonable space at the site of the work and access to the same for receiving, handling, storing and working material. No complete or definite locations for the work were ever given to the contractors. No comprehensive plans or sketch of the locations were ever furnished the contractors. Locations were given piecemeal and partially, thus preventing the contractors from laying out their plans in advance. It was said that where the contractor is delayed in the performance of his contract work and suffers losses that would not have been suffered except for the government's delay and failure to observe its obligations under the contract, the contractor is entitled to recover therefor.

Where a contract was made for removal and construction of a pier of a bridge and work is suspended by order of the government on account of an existing war and is subsequently renewed, the contractor is entitled to all damages caused by the suspension of the work as "for any improper interference with the work of a contractor, the United States, like individuals, are liable."

Practical Rules

While it is difficult to lay down practical rules of conduct governing all cases of delays and interferences, the following suggestions are made for the guidance and protection of contractors whose contracts are unreasonably delayed or interfered with:

1. The contractor should determine immediately upon his work being suspended or interfered with whether it is to his interest to submit to the delay and continue the work or whether the contract should be treated as breached and hence abandoned. This latter is a serious step not always justified by every delay or interference with the work and should never be taken without legal advice.

2. If he determines to abandon the contract he should give immediate notice of that action to the highest officer approving the original contract, and such additional notice to subordinate officers in immediate charge as may seem necessary, stating clearly his reasons for so doing and announcing his purpose to claim damages.

3. In the event that he is going on with the contract at the conclusion of the suspension, he should reduce his expenses to the greatest extent consistent with readiness to resume work at the expiration of the suspension as the courts will allow him only for the absolutely necessary expenses. Here also prudence indicates that notice should be given of his intention to claim damages for the losses incurred.

4. A contractor, before bidding, should always ascertain from the specifications whether responsibility for delays of government officers is thrown upon him by any of the provisions of the contract or specifications. If he is to be held responsible for delays caused entirely by the other party to the contract, that contingency should enter into his bid and should influence its amount. A margin for contingencies or losses occasioned by delay should always be allowed if the contract provisions are to be such that he can claim no damages from the government for the delays incurred.

5. It will be the safe and prudent thing always, whether a delay is caused by an act or failure to act on the part of the contracting officer, or from other cause not the fault of the contractor, for the contractor to give immediate notice in writing to the contracting officer of the fact of such delay and its probable consequences. One cannot safely wait to know the exact consequences. The timely notice or protest will protect the contractor. Nothing else will certainly do so.

This is, as will be obvious, with relation to public contracts with governmen officials. If might or might not apply in all respects to private contracts with private individuals.

Where the contract was to furnish stone for the construction of a building as "required" the term "required" means all needed for the wants of the service; hence the government is obligated to take all the stone needed for the construction of the building.

In one case doubts arose as to whether the building should be completed with the kind of stone for which the contract was made or with some other material. This question required examination by several commissions. Meanwhile the work was suspended. The stone was ultimately taken. For all the damage caused by the intervening suspension of the work the contractor was allowed to recover.

These principles were reaffirmed by the court as recently as 1936, when damages were allowed for delay in furnishing drawings and models for a building. The principle was thus laid down:

> Where the Government agrees to perform a certain work or to furnish certain articles and fails to carry out its part of the contract, it is liable for the actual damages resulting from its failure to perform. It is too obvious to need argument that the Government is responsible for the actual damages occasioned by the delay in furnishing these drawings and models. The cost of the new scaffolding is a part of the damages suffered and is includable in the amount plaintiff is entitled to recover, occasioned by the delay of the defendant.

The performance of the work was thrown into cold weather and the contractor furnished temporary heat necessary to protect the work from injury by the cold weather. This was held to be a direct consequence of the delay on this ground:

> In our opinion, the furnishing of this temporary heat by the plaintiff would have been unnecessary if plaintiff had not been delayed by the government in the performance of its work, and, having been delayed by the government, it is entitled to recover the actual damages it has sustained, which in this case is the additional expense it has incurred.

In another case the government was obligated to deliver certain material to the contractor to be worked up, and delayed nine weeks in doing so. The contractor was thus compelled to maintain an organization

for much longer than it would have been obliged to do if the government had complied promptly with its part of the contract. For this damage the contractor was held entitled to be compensated.

In a series of cases involving the construction of ships, the government agreed to furnish armor to be placed on the vessels. It delayed doing so. The courts have, in such cases, allowed damages to the contractor for the delay of the government in furnishing the armor and ordnance which it had agreed to furnish.

Delays by other contractors

Sometimes the work of the principal contractor depends upon that of other contractors engaged by the government to perform stipulated portions of the work. In such cases the government is often held liable for the delays of other contractors on the ground that it is primarily responsible for the preparation of the site and other preliminary work, and that this responsibility cannot be avoided by letting the work under contract.

Where the government agreed to have the foundations for a building ready to enable the contractor to begin his work and the foundations were let under a separate contract and the delay was due to the fault of the contractor for the foundations, the government was held responsible for the delay of such other contractor and was required to make compensation to the contractor for the building for the delay in not having the foundations ready.

In a case in which the government claimed that the delays and interferences for which the contractors brought suit were caused by other contractors, the court refused to adopt the default of the other contractors as an excuse for the nonperformance of the obligations of the government under its contract, saying:

> The contractor, it seems to us, had a lawful right to prepare at once to perform the contract and rely upon the government to comply with its terms, and there is nothing in the record warranting the court to hold that the government possessed the contractual right to delay and retard performance because the officials in charge deemed the contractor's work of less pressing importance than other work going on in the yard. We think the contractual obligation of the government which we cannot ignore, under the quoted paragraphs of the specifications imposed a duty to so act with respect thereto as to enable the plaintiffs to perform their contract work according to the contract, and that the government failed to observe the same.

Where a contract was made for the construction of two wharves and the contractors employed by the government for doing the dredging necessary to enable the wharves to be constructed delay their work so that the wharf contractors could not proceed with their work until the dredging was completed, the government is responsible for the delay of the contractors employed by it to do the preliminary dredging and the contractors for the wharves are entitled to be compensated for the reasonable damages sustained by them in consequence of the delay in the prosecution of the work of the dredging contractors.

> The measure of the damages to plaintiffs should be the actual and direct loss to them occasioned by the delay, as near as it can be ascertained, not remote or speculative damages that would not have been anticipated by the parties upon the happening of the events that caused the delay. Without discussing the various elements in plaintiffs' contention, composing these damages, we think it is a sufficient statement of the proper rule to be applied that the plaintiffs are entitled to receive the value of the services of their employees and machinery during the time of the delay in the business in which they were then engaged, etc.

Provisions against damages

There is a class of cases founded on provisions sometimes found in government contracts that the government is not to be held responsible in damages for delays occurring from any cause. These provisions have sometimes been set up with success by the government to prevent recovery by contractors for damages caused by delays.

The tendency of recent decisions is to give a very limited scope to such provisions as excusing a party to a contract from its own delinquencies.

It was said in a thoroughly considered decision that such provisions only cover delays due to activities with respect to construction and do not excuse inaction or prevent the government from being liable for failure to carry out a duty imposed upon it by the contract. It was there said that "the contract did not authorize an indefinite suspension of all the work, an interference that precluded progress and involved the plaintiff in irreparable loss." This view is as sound in justice as it is in law.

Protests against delays

The standard form of construction contract provides "that the contractor shall within ten days from the beginning of any such delays notify the contracting officer in writing of the causes of delay, who shall ascertain the facts and the extent of the delay," etc. This provision is usually understood not to extend to delays caused by the government officers themselves as they are supposed to know the facts of their own delays.

This was well illustrated by two cases of the same contractor, decided about the same time. In one case where he was delayed 412 days by the government in the performance of his contract and incurred nearly $12,000 damages by reason of such delays, he was held entitled to recover the amount of damages caused by such delay, including additional premium for the renewal bond covering the contract. In the other case, there was an agreement as to the facts showing that the contractor made no complaint of the delay but proceeded with the work as if no obstructions had been placed in his way by the government, and in that case he was held not entitled to recover anything.

Where appeals against the action of the contracting officer were unreasonably rejected, the contractor was excused from taking further appeals or making further protests as such action would have been futile, in view of the fact that previous protests had been ignored.

Much more was this the case where the contracting officer declined to grant reasonable and courteous interviews and dismissed polite appeals with harsh and profane language.

Where the government suspended work on a building in progress of construction and the contractor asked to be allowed either to continue or to be relieved from any further obligation under the contract and such request was refused and he was subsequently required to resume work, he is entitled to recover all damages caused by the delay.

The Court of Claims may make a general finding of the amount of damages and when so found the amount is conclusive.

Elevated Concrete Tanks of Record Size

by Henry D. Dewell

Consulting Structural Engineer, San Francisco, Calif.

Sacramento builds two 3,000,000-gal. balancing reservoirs with encased welded steel shells and concrete bottoms on concrete supporting structures 75-ft. high

Two elevated water tanks of reinforced concrete, believed to be the largest of their type, recently were put into service at Sacramento, where flat topography made it necessary that balancing reservoirs for the city water system be raised 75 ft. above ground level. The tank walls are lined inside with steel plate imbedded in the reinforced concrete floors, which have articulated joints. The structures as a whole were designed to resist earthquakes. Their cost was less than the estimate for structural steel tanks of the same height and capacity.

The two tanks are alike except that, because of lower ground and better foundation conditions, one has smaller footings and is about 7 ft. taller than the other. Each tank holds 3,000,000 gal., has an interior diameter of 144 ft. and a maximum wetted wall height of 26 ft. The floor of the tank in the higher structure is 77 ft. above the ground, giving an over-all height exceeding 100 ft.

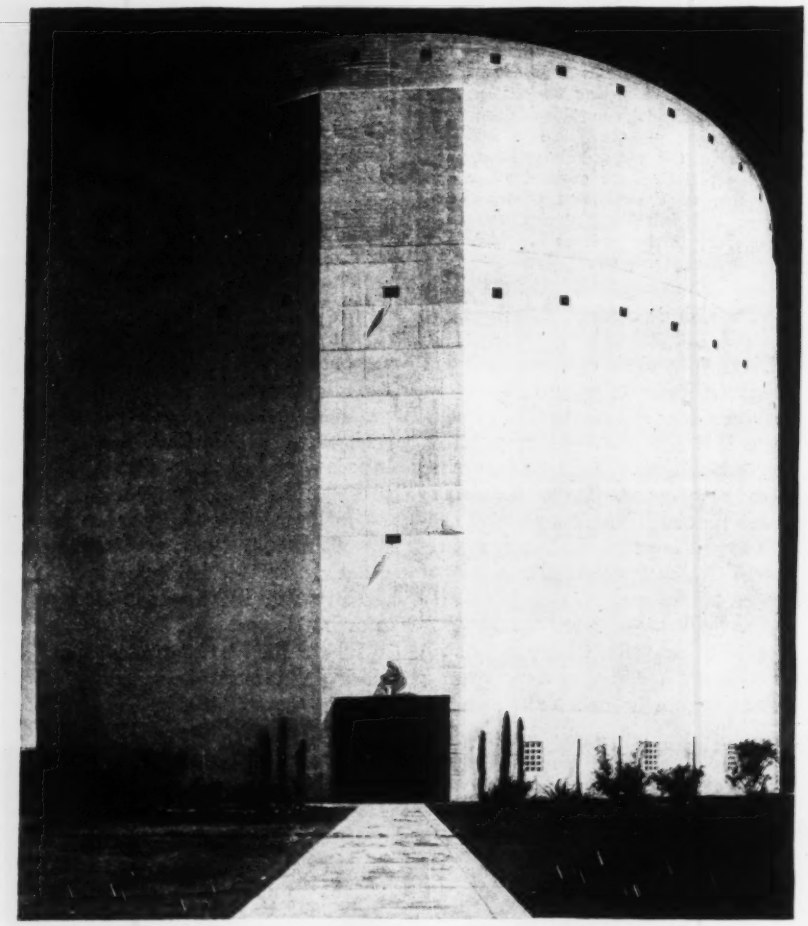

Fig. 1. Elevated water tank in concrete housing at Sacramento. Concrete columns support flat bottom tank with steel shell 75 ft. above ground.

Exceptions to the reinforced concrete construction are the water-resisting walls, which are made up of welded steel plates surrounded by exterior walls of reinforced concrete, and the roofs, which are framed timber with t. and g. redwood sheathing covered with asbestos roofing. The timber roof structure is supported by concrete ring beams and columns. A central well, 6 ft. in diameter with an 8-in. reinforced concrete wall gives access to tank interior and roof. Ventilation is provided by screened openings and a central roof ventilator.

The tank supporting structure consists of a cylindrical reinforced concrete wall with an inside diameter of 144 ft., and 44 reinforced concrete columns arranged in three concentric rings with diameters of 24, 64 and 109 ft. respectively. Two horizontal bracing systems of radial and circumferential struts divide the supporting structure into three stories and give lateral support to columns and walls, enabling them to act as one unit in resisting lateral forces.

Tank walls

The steel wall of each tank, although surrounded by an outer reinforced concrete shell to which it is bonded by steel anchors, was designed to resist the full pressure of the contained water. The function of the shell is three-fold; (1) it acts with the steel wall in resisting a possible surge of the contained water such as might be caused by an earthquake, (2) it affords a protective covering that prevents corrosion of the steel, and, (3) it gives a pleasing appear-

ance to the finished job, quite important in so conspicuous a structure.

Specified construction sequence called for completing the steel walls and testing them under full water load before the surrounding concrete shell was poured. These tests showed neither leaks nor sweating of joints. While the tanks were still full of water, the concrete walls were cast around them. After a 28-day curing period the water was removed and the inner faces of the steel walls sandblasted and painted. The steel walls, when relieved of pressure by the emptying of the tanks, contracted and, by reason of the bond between the steel wall and surrounding concrete, drew the latter inward and thus put the outer shell in compression, leaving residual stress in the steel wall. This was, in effect, a method of pre-stressing the reinforced concrete shell.

When the tanks were again filled, water pressure forced the reinforced concrete shells back to their original position and condition of zero stress, except for any effects of temperature and shrinkage. This mutual action between steel walls and concrete shells will continue with subsequent filling and emptying of the tanks. As a result of this arrangement the concrete walls will never be in tension from water pressure.

During the design period it was thought that the natural bond between steel wall and surrounding concrete might be sufficient to make the two act together and tests were therefore made of the bond between sandblasted steel plates and concrete cast against them. These tests indicated that the bond between the concrete and clean, sandblasted surfaces of steel plates had a minimum value of 90 lb. per sq. in. at the age of 28 days, about ten times the computed bond stress that could occur. Accordingly the specifications were drawn to require the exterior of the steel shell to be sandblasted before casting the adjacent concrete.

Later it became evident that the construction period would continue into the wet weather season and hence films of rust might be expected to develop on the clean steel surfaces before concrete could be poured. This rust would be difficult, if not impractical, to remove because of subsequent placement of concrete wall reinforcement. Therefore supplementary tests were made to test the bond between concrete and steel which had been sandblasted and subsequently rusted. Results in this second series of tests were so erratic that it was decided not to depend on natural bond; steel strap anchors projecting into the concrete forms were therefore welded to the steel walls to give mechanical bond.

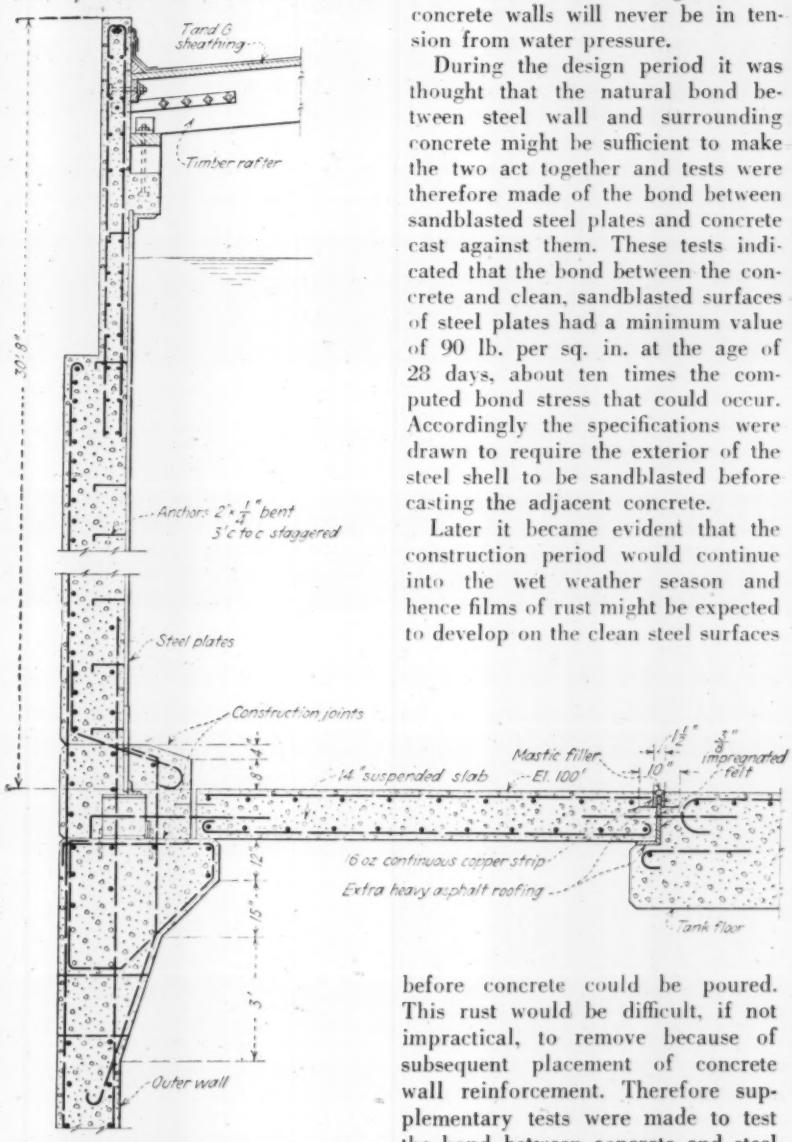

Fig. 2. Tank details showing particularly the suspended slab joints, the concrete reinforcing and the welded steel plate shell.

Fig. 3. Interior view of supporting structure within the outer concrete shell.

The bottom course of plates in the steel wall is embedded for half its depth in the concrete of the floor slab. This lowest ring of $\frac{3}{4}$-in. plate, reinforced by a steel angle welded to its lower edge, is anchored into the floor by $\frac{3}{4}$-in. round anchors welded on at 18-in. intervals. On account of the embedment, this plate acts both as a vertical beam in bending and as a hoop in ring tension.

The top of the steel wall is reinforced by an angle welded on to afford stiffness during construction. The top of the concrete wall is stiffened by a concrete ledge to which the 3 x 16-in. redwood rafters are bolted with heavy galvanized steel straps. The roof construction includes anchorage of rafters (1) to the top of the concrete wall, (2) to the concrete framework supporting the roof and (3) to the concrete well in the center of the tank. Thus the roof as

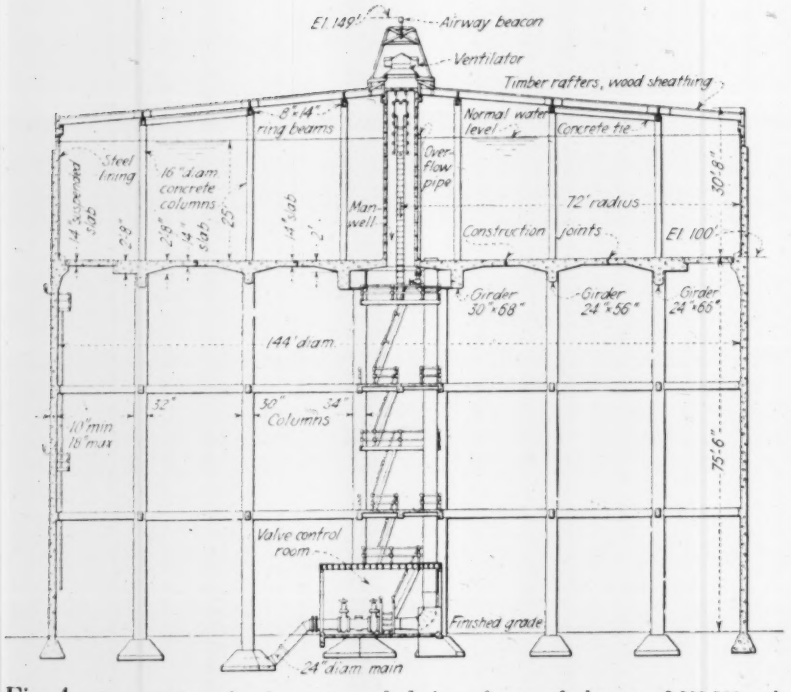

Fig. 4. Cross-section showing structural design of one of the two 3,000,000 gal. elevated tanks for Sacramento water supply.

a whole, including the 2-in. sheathing, provides a strong, rigid, horizontal diaphragm that gives stiffness to the tank walls and strengthens the structure against earthquakes and the water surges that might follow.

Tank floor

The tank floor is a combination of reinforced concrete ring girders and haunched floor slabs. Two circumferential articulated or hinged joints were placed at the two lines of contraflexure in the outer ring floor panels of the floor slab to permit of such differential vertical movement as will occur between interior columns and exterior wall due to variation in settlement of foundations and elastic deformations of columns and walls. Obviously, there will be such differential vertical movements because the columns carry water load almost exclusively while loads on the exterior walls are about half water load and half dead load. Also the maximum unit stress in the columns is about five times that in the walls.

To minimize the effects of shrinkage, the floor slab was laid in units separated from each other by water stops of 16-oz. copper with welded or brazed joints. These construction joints are both circumferential. (at the center of the slabs) and radial (in alternate slabs). Units of adjacent floor slabs were poured in alternate panels.

The inside surface of the circular supporting wall beneath each tank is cylindrical while the exterior surface forms a prism of 24 sides. The wall thickness varies from a minimum of 10 in. to a maximum of 17 in.; the average is 12½ in. The exterior face of the wall is reinforced with horizontal ½-in. round bars at 8-in. centers and vertical ½-in. round bars at 16-in. centers. The reinforcement of the interior face consists of horizontal ½-in. round bars at 12-in. centers and vertical ½-in. round bars at 16-in. centers. Horizontal reinforcement in the wall totals 0.334 per cent; vertical reinforcement totals 0.200 per cent, both figures being based on average wall sections.

The cylindrical form of the wall, its diameter-height ratio and its two planes of intermediate horizontal bracing give it great inherent strength in resistance to both vertical and horizontal loads. An enlargement of the top of the wall forms a ledge for supporting the outer edge of the tank floor slab; the connection between the ledge and the floor slab constitutes the outer circumferential articulated joint, purposely made incapable of transmitting bending moment. The joint is, however, capable of transferring horizontal thrust from one member to the other through ¾-in. round rods embedded in the concrete of slab and wall and located at the center of the slab. The joint causes the vertical load of floor slab and water to put a bending moment into the upper portion of the wall. This moment is resisted by the upper story of the wall acting partly as a vertical beam and partly in ring tension; the proportion of each is determined by the relative deflections in bending and in ring tension. The maximum moment occurs at the top of the wall and diminishes rapidly to the plane of contraflexure, about 10 ft. below the tank floor. The portion of the wall subject to these combined stresses was reinforced accordingly.

The columns are circular in section, spirally reinforced and have 1½ in. of concrete outside the steel cage. They are designed in accordance with the building regulations for reinforced concrete not in general use (A.C.I. 501-23) in accordance with which only the concrete within the spiral reinforcement, or the core area of the column, is assumed to take stress.

Foundations

Two sets of soil tests, original and confirming, respectively, were made for both tanks by (1) La Barre & Converse and (2) Abbot A. Hanks, Inc.-Hyde Forbes. By means of special machines, loads were placed on the soil in increments. The deflection for each increment of load was accurately determined, recorded automatically in the first case and manually in the second, and the load released after stabilization and the recording of negative deflection. Thus the behavior of the soil under load was tested and also determination was made of that point beyond which further loads caused permanent settlement.

Two distinct differences in testing procedure are to be noted. In one set of tests, the steel pressure plates bore against the sides of the test hole in a stratum judged by its relative resistance to indentation to be less resistant to vertical pressure than the strata above. In the other set, the pressure plates bore vertically upon the soil at the bottom of the footings. The results, interpreted by the respective consultants, were substantially the same and indicated that

the soil at the site of Tank No. 1 had a yield point of not less than 20,000 lb. per sq. ft., while at Tank No. 2 the yield point was about 14,000 lb. per sq. ft. On the basis of these tests, the maximum working pressures were established at 4 tons per sq. ft. for Tank No. 1 and 3 tons per sq. ft. for Tank No. 2.

There is no record of a major earthquake at Sacramento, but it was thought prudent to design these overhead storage tanks to resist lateral force. The tank structures are very different from elevated steel water towers in being definitely rigid instead of flexible. This is apparent from the fact that computations indicate that when full the tanks have a natural period of vibration of about 0.2 sec. as compared with periods of elevated structural steel tank towers of perhaps 1.5 sec.

Computations indicate that the structures will withstand a horizontal, static force of about 15 per cent of their loaded weight without exceeding the normal working stresses for the materials of which they are constructed. At maximum unit stresses of 1-1/3 times the normal working stresses, the earthquake resistance factor would approach 20 per cent. In the event of earthquake, substantially the total resistance would be in the circular supporting wall of each tank, as the interior columns have slight stiffness.

The assumption was made that an earthquake will cause the water in the tank to surge and the force of this surge was calculated in accordance with the theory presented by Prof. Lydick S. Jacobsen, Stanford University, in the *Seismological Bulletin* of January, 1934. For a lateral force of 10 per cent, the surge force was found to be 239,000 lb. This force will be resisted by the combined steel and reinforced concrete wall of the tank acting partly in hoop tension and partly as a vertical slab (1) supported at the top by the roof and (2) at the bottom supported and restrained by the tank floor slab and the supporting wall. The cylindrical reinforced concrete wall of the circular well, to which the roof framing is anchored, will also strengthen and stiffen the structure in its resistance to earthquake.

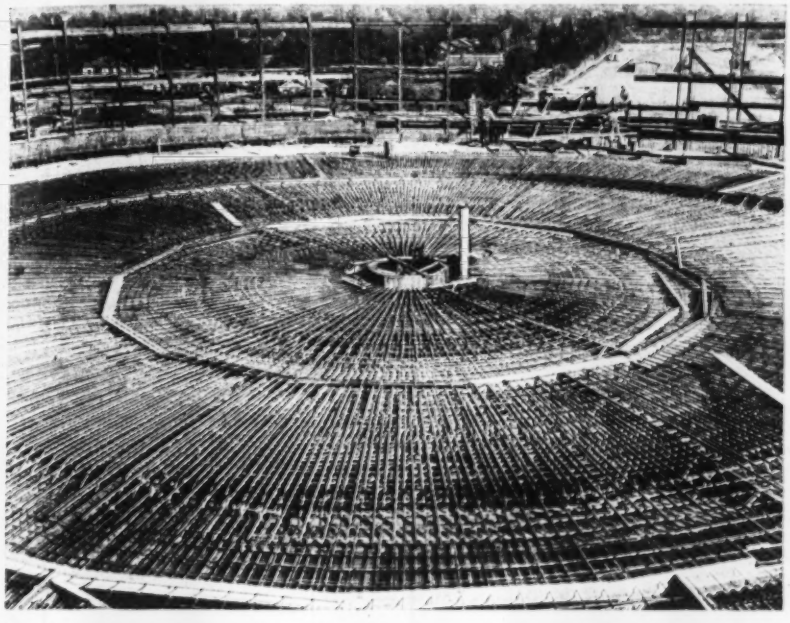

Fig. 5. The floor of the tank with reinforcement in place ready for concrete. Steel shell erection is under way on the far side.

Consideration was given to the installation of baffle walls in the tanks to decrease or prevent surge of water during earthquake. Uncertainty as to the effectiveness of such baffles, complications that would result from their installation and the ability of the tank walls to resist water surge without them led to a decision against their use.

An ultimate compressive strength in the concrete of 2,400 lb. per sq. in. in 28 days was assumed for the foundations and 3,000 lb. per sq. in. for all concrete above the foundations. To be sure that all concrete in the structure, including foundations, would have these strengths, proportions were specified that would give average test values at least 25 per cent greater. Test cylinders made during construction indicated concrete strength to be considerably above specified values.

All joints in the steel walls of the tanks were welded, using shielded arc electrodes. The welding specifications closely followed those of the American Petroleum Institute and included the requirement that "Each welder shall pass qualification tests —carried out under the direct supervision of a testing laboratory to be designated by the city engineer—at the expense of the contractor". Of the fourteen welders who took the prescribed tests, only seven passed. The specifications also called for special testing and inspection of steel and welding. Although the cost of this special inspection exceeded the allowance, the results obtained justified the expense. The workmanship obtained was such that it is felt certain that the welded joints will develop the strength of the plates.

Welding the 6,090 lin. ft. of joints in the two tanks required 1,704 man hours. The hourly rate of $1.375 made the average labor cost of welding $0.385 per lin. ft. of joint, exclusive of a superintendent's time.

When the tanks were filled for testing, some small leakage developed in the construction joints of the floor and also in the joint between the steel wall and the concrete floor. Subsequent treatment of these joints with Inertol and special asbestos fiber mastic corrected this.

The design and construction of the tanks was carried out under the direction of officials of the city of Sacramento as follows: James S. Dean, city manager, Fred J. Klaus, city engineer, R. E. Mittelstaedt, superintendent of the division of water, and Carl H. Hoskinson, chief engineer of the division of water. The writer was consulting structural engineer in immediate charge of the preparation of plans and specifications and the supervision of construction. Chas. F. Dean was consulting architect. The Campbell Construction Co. was the general contractor. The total contract cost was about $320,000 and the work was done under a grant from the PWA.

Better Concrete Mixers Needed

by LEWIS H. TUTHILL

Testing Engineer, Metropolitan Water District of Southern California, Los Angeles, Calif.

Present mixers have shortcomings which can be remedied if there is demand that certain requirements be met

IMPROVEMENT in concrete-mixer design is a subject of wide interest, judging from reactions to a recent letter-to-the-editor in *Engineering News-Record*, (Aug. 5, 1937, p. 212) which indicate a healthy desire to do something about it. Fortunately, something can be done. The first step should be taken by those engineers who fix what specifications shall require in mixer performance. The following remarks give some suggestions along this line, together with an outline of the dangers and faults common to mixers now in use. These shortcomings must be understood if they are to be avoided; once there is concerted demand that improvement be made there should be little difficulty in accomplishing it.

The situation was well summarized recently by a representative of a well-known mixer manufacturer who made the highly significant suggestion that "recognizable improvement in large mixers probably will not be forthcoming unless and until engineers specify and insist upon better mixer performance. When performance is improved credit should be given for it in corresponding reduction of mixing time so long as uniform distribution of the ingredients is attained with the essential degree of hydration and plasticity." This extremely valuable hint is equally applicable to all ordinary-type mixers and to very large mixers for mass concrete. If the suggestion can be put into effect, marked improvement in uniformity and quality of concrete will result and handling and placing will be expedited by eliminating separation on discharge.

Faults in mixer design

Fortunately the principal faults of mixers are few. However, they often constitute major difficulties that cannot very well be corrected on the job in an otherwise well-handled concreting operation. These principal faults are:

(1) Lack of end-to-end exchange of materials during mixing in most large and some smaller mixers.

(2) Separation of coarse aggregate from mortar when discharging.

(3) Holding back coarse aggregate to be discharged separately at the end of the batch. (Separation described in 2 and 3 is principally evident when the concrete involved contains less than 1½ bbl. of cement per cubic yard, has aggregate larger than 1¼ in., contains less than 40 per cent sand, and has a slump of more than 3 in.)

(4) Inability of some small mixers to mix and discharge concrete at the relatively stiff but plastic consistencies which may now be placed effectively by vibration in massive portions of the work.

(5) The need of some mixers to have mixing water dribbled in during most of the mixing period so that a uniform consistency shall result at the end of a nominal mixing time. (This is merely another aspect of lack of good end-to-end exchange during mixing.)

The revolving drum of an efficient mixer should have a combination of shape, design and location of blades that will give effective and frequent end-to-end transfer of the materials in the mixer, at the same time that the material is rolled over on itself as the mixer rotates.

Proper charging, however, will materially improve the efficiency of any mixer, particularly a large mixer handling mass concrete. Solid materials should be placed in the charging hopper in such sequence that no one material will enter separately; proportional amounts of each (particularly of cement and sand) must be in all parts of the stream of materials flowing into the mixer. To avoid gumming and better to insure uniformity, cement should never be charged individually (particularly not ahead of the aggregates) but should be enclosed within the stream of inflowing ingredients.

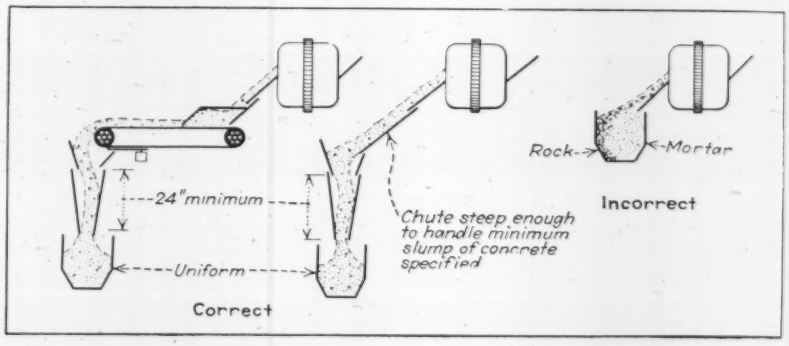

Fig. 1. Preventing separation in the process of discharging concrete from the mixer—correct and incorrect methods.

Further, part of the water for a batch should be the first ingredient to enter the mixer; it should continue to flow while solids are entering and it should have completed flowing not later than one revolution of the drum after the last of the solids has entered. Where mixing action is as it should be, the turbulence of mixing in the presence of water will promptly wet the cement; hence the cement will be thoroughly wetted most speedily if all of the mixing water is present as early as is consistent with proper charging. The sooner the cement is thoroughly wetted, the sooner proper mixing action will thoroughly and evenly distribute it among and upon the aggregates. Hence, assuming an efficient mixer, the recommendation is made that the mixing water enter promptly, and that measurement of

mixing time begin after all ingredients including water are in the mixer.

The efficiency of the mixing operation in all types of mixers should be such that at the end of the prescribed or permitted mixing period, the sand-cement and the water-cement ratio of the mortar as well as the ratio of coarse aggregate to mortar in any part of the batch is within 10 per cent of corresponding content in any other part. This should be tested by taking three samples from well separated localities in the mixer, and testing them by means of the U. S. Bureau of Reclamation "Mixer Efficiency Test Procedure" or the Iowa State College method for "Field Determination of the Constituents of Fresh Concrete."

The development of a guide to improvement in mixer charging methods was made at Grand Coulee Dam at the outset of work there and was reported in *Engineering News-Record*, October 15, 1936, p. 546.

Suggested specifications

For encouraging improvement in mixers larger than 1-yd., particularly for mixing mass concrete, the following specification requirements are suggested: (1) A nominal minimum net mixing time of 1 min. for the first yard plus ¼ min. for each additional yard of capacity should be required. (2) The use of mixers unable to pass the tests for mixer efficiency (mentioned in the foregoing) after twice this period of mixing when charged indescriminately, should be prohibited (indiscriminate charging is recommended for this approval test so as to insure thorough end-to-end exchange in the mixing action). (3) Credit for improvement in design should be given by requiring of mixers that meet these two specifications only so much mixing time (in addition to the established minimum, based on mixer size) as may be necessary to enable the batch to meet the efficiency test when the mixer is charged and operated in accordance with practice which may be established as routine for the job. In other words, this stipulation will make the contractor want a well-designed mixer because it will save time.

Separation of coarse aggregate from otherwise perfectly mixed concrete as it is discharged from the mixer often impairs the quality of workmanship and adds to the labor required to place the concrete. The only way this can be avoided is to require that all types of mixers, including truck mixers and agitators which discharge directly into hoppers, buggies, cars, buckets, etc., be equipped in such a manner that the concrete will *drop vertically, and not diagonally*, into these containers. If the mixers cannot be so equipped by reason of their mounting, chutes or conveyors with proper end control must be used to accomplish this objective. The common makeshift baffle on the short mixer discharge chute will not properly correct the serious separation usually found at this point when comparatively lean concrete with large aggregate is being used.

Concrete of this type should not be allowed to discharge directly from a chute (or from anything simulating uncontrolled chute action) on to anything except a conveyor belt or a longer chute which is controlled at the end in such a way as to give ample assurance of a vertical drop into the center of the receiving container or forms. This applies particularly to such equipment as the boom-and-bucket arrangement on the common paver, which should be replaced by a short conveyor with proper end control to produce a vertically dropping stream of concrete. This very important requirement is illustrated in the accompanying sketch. Further suggestions along this same line were illustrated in *Engineering News-Record*, Dec. 31, 1936, p. 934.

Some mixers tend to throw out several cubic feet of coarse aggregate containing very little mortar at the latter end of each batch discharge. This is a highly unsatisfactory performance. Requirement should be made that the blade arrangement and discharge mechanism of all types of mixers, including truck mixers and agitators, be such that there will be no appreciable additional percentage of coarse aggregate in the last 10 or 15 per cent of concrete discharged as compared with the first 10 or 15 per cent.

A convenient test for rating the mixer on this score can be made by comparing the weights of coarse aggregate retained when 100 lb. of concrete from each end of the batch is washed over a ½-in. screen. If this requirement is not met, the fraction of each batch found to contain excessive amounts of coarse aggregate should be withheld from discharge and mixed with the succeeding batch. In such a case, the size of batches ordinarily charging the mixer should be reduced by this average amount.

The discharge facilities of all types of mixers should be capable of readily delivering concrete of the stiffest plastic consistencies which can be placed in certain types of work by means of vibration. Mixers that are capable in this respect will be able to discharge concrete of 1-in. slump with dispatch.

The recommendations made here are under consideration as a part of the report of American Concrete Institute Committee 614, whose published assignment is the preparation of a recommended practice for the measurement, mixing, and placing of concrete.

Death Valley Has New Road

For the first time Death Valley National Monument in California has an all-high-gear road from the west resulting from the completion of the Darwin Cut-off, a section of the Mount Whitney-Death Valley Highway. The Darwin Cut-off extends from a point west of the town of Darwin into Panamint Sink in Death Valley. Adjoining Panamint Sink is Badwater, lowest point in North America, 280 feet below sea level. Mount Whitney, in Sequoia National Park, at the other end of the Mount Whitney-Death Valley Highway, is the highest point in continental United States, rising 14,494.7 feet above sea level. The road does not go to Whitney's peak, however, reaching its greatest elevation near 8,500 feet.

Motorists already are prophesying that the Darwin Cut-off will be the most frequented entrance into Death Valley National Monument. The general grade of Darwin Cut-off is 6 to 7 per cent, in which are 72 easy curves as contrasted with the old route which contained more than 240 sharp turns and had a grade ranging from 12 to 22 percent. Cloudbursts annually made the old road impassable. The Cut-off lies above the paths of cloudbursts and shortens the distance by more than 2 miles.

Removing Submerged Steel By Blasting

by LaMotte Grover

Former Office Bridge Engineer, Kansas State Highway Department, Topeka, Kansas

Exploding charges sunk in metal tubes break up truss members of flood-wrecked bridge

In the construction of the piers for a new highway bridge across the Kansas River at Manhattan, Kan., one of the major problems was to sink cofferdams for two piers at points where the streambed was obstructed by old steel truss spans from the Rock Island R. R. bridge, just upstream, which were washed out during the 1935 flood. The railway company, after an unsuccessful attempt to salvage the trusses, had removed the steelwork that was accessible, leaving the remainder of the steel, which was a very large part of it, in the bed of the stream. This submerged steel lay in such a position that it would interfere very seriously with the driving of sheeting for the highway bridge cofferdams, and in such a position that it was very difficult to locate the various members, some of which were embedded deep in the sand. The use of dynamite to break up these members and permit them to be removed in some cases or the sheeting to be driven around them in others, proved to be effective and economical.

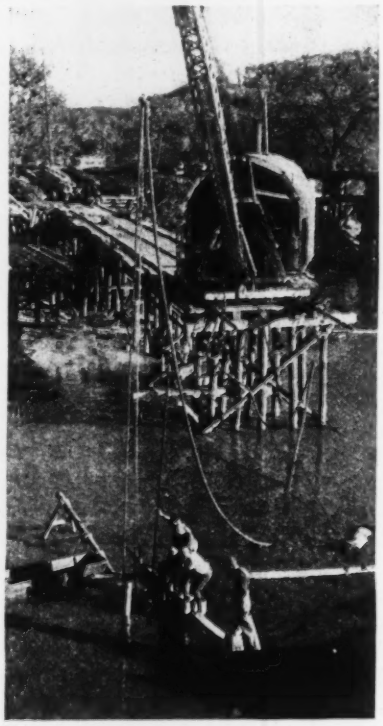

Fig. 1. Placing dynamite in metal tubes sunk either side of a submerged steel member

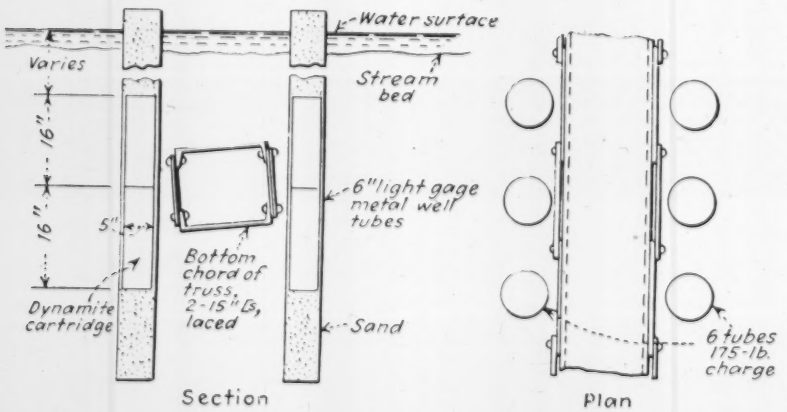

Fig. 2. Arrangement of dynamite charges whose explosion severed the steel member and permitted its removal.

After some preliminary clearing had been done, a frame was erected for each cofferdam at the location to be occupied later by the walers. Then a 1¼-in. jet operated from a steam pump was used to probe around the frame and locate the various members that would interfere with the driving of the sheeting. At each point where such a member was located, six 25-ft. sections of 6-in. diameter 20-ga.-metal well tubing with screw joints were jetted down, three on each side of the member and as close to it as possible. In each of these tubes two sticks of 60 per cent straight nitroglycerin dyanmite, 5 in. by 16 in., were placed, one above the elevation of the center of the member to be cut and the other below this elevation; the space in each tube above and below the dynamite cartridges was filled with sand as shown in Fig. 2.

The charges of dynamite in all six tubes were exploded simultaneously. The explosion tended to shear the member in two at the point of discharge, but in some cases, due to the proximity of rock and shale in the streambed, the members were lifted completely out of the water where they could be cut up with a gas torch. In other cases the members were broken away from connections by tearing through the riveted holes. One 42-in. built-up floorbeam was sheared in two by one of the charges. Each time a shot was fired, the frame had to be reset to correct alignment, and other members relocated with accuracy.

Before the driving of the sheeting was completed it was found that some of the obstructing members had not been entirely cleared out of line. This made it necessary to remove some of the sheeting so as to blast out the obstruction, and then redrive the sheeting. This additional blasting was done without seriously distorting the part of the cofferdam that was left in place. Despite these difficulties effective results were accomplished and probably at less cost than would have been required for other methods that were proposed.

The bridge at Manhattan is being constructed by the Keliher Construction Co., Dallas, Texas. Gordon Walker is superintendent for the contractor and L. G. Bean, resident engineer for the state highway commission.

FIG. 1. FASCINES ARE BUILT IN A CONTINUOUS LINE NEAR THE TOP OF THE SLOPE AND ROLLED INTO POSITION.

New Type Brush Revetment

by ARTHUR G. TRUDEAU

Captain, Corps of Engineers, U.S.A., Seattle, Wash.

Anchor posts on slope and concrete-cored fascines are novelties of brush revetment being used for bank protection on western Washington rivers

A BRUSH REVETMENT differing interestingly in construction from revetments of similar material used on the Mississippi, Missouri and other streams of the Mississippi valley has been developed on some of the streams of western Washington. These rivers are comparatively short and as they debouch from the mountains into fertile valleys they carry heavy loads of debris, which deposit in the lower and flatter reaches of the streams. Winter snows, when melted by warm winds accompanied by heavy rains, often produce large flows of water, whose damaging effect is increased by drift, logs and other debris. With the development of the valleys the need for stabilizing these river channels and preventing flood damage has become more urgent.

The U. S. Engineer Department was given the problem of working out a bank-protection program in keeping with a comprehensive stream-regulation plan for the several basins involved. The most acceptable program, it was made clear, would be that which would help as much as possible in meeting the unemployment relief needs of the Puget Sound region. This latter specification, of course, required the cost for materials and equipment to be made relatively low compared with the outlay for labor. Accordingly, a plan was developed for revetting river banks with brush in a way which provides excellent protection at low cost and yet spends most of the money directly for labor.

Mat construction

The mat structure is best indicated by Fig. 2, in which the unusual items to be noted are the bank stakes and the underwater fascines with concrete cores. A protection of this type is not in itself particularly durable, due to the drying out, breaking, rotting, etc. of the brush used; the eventual success of the revetment depends on silting in of the mattress and growth of bank protective vegetation such as willows or berry bushes and as stated later these developments are encouraged.

The bank is graded to a 1 on 3 slope using ¾-yd. draglines or, on the lower banks, teams and scrapers. The banks vary in height from 8 to 20 ft. Where very high banks are involved the revetment generally is carried above extreme flood stage on a 1 on 3 slope and thence upward on a steeper slope, according to the type of soil found at the point of operation.

Since ultimate success of the work depends in large measure on bank growth, at least 30 per cent of all brush used in the revetment is willow. The remainder is fir. The best material is brush 12 to 20 ft. long with butts not over 4 in. in diameter. The successive steps involved in placing revetment on the graded bank are these:

1. Willow stakes 3 ft. long are driven into the slope in rows 4 to 6 ft. apart parallel to the bank, leaving 14 in. projecting above the finished slope surface; the stakes in each row are 6 ft. apart except that on bends this spacing is varied to keep the rows normal to the water's edge.

2. With the stakes in place a ¾-in. galvanized wire cable is laid (Fig. 2) along each row parallel to the bank. This is done, beginning upstream, by hauling reels of cable on skids along the bank by teams after the upstream ends have been securely

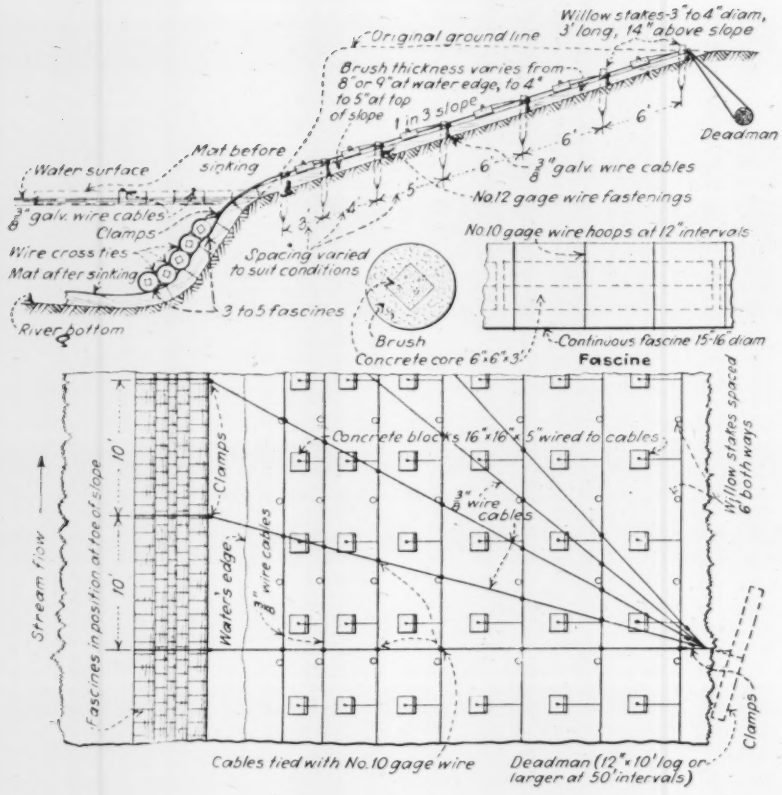

Fig. 2. Revetment details showing toe fascines and the methods of weighting and anchoring the brush mat.

anchored to deadmen. Intermediate deadmen, staggered in the various rows, are placed at about 1,000-ft. intervals. A short length of 12-gage wire is then fastened by one end to the cable at each stake and the free end is wrapped temporarily to the top of the stake; the length of the 12-gage wires depends on the thickness of mattress to be secured and on whether poles or additional wire ropes are to be placed as top binders.

3. Construction of the mat ordinarily proceeds from the upstream end of the revetment. It begins by placing the water mat or lower bank apron first and continuing up the slope. A floating portion or apron is built first, of a width such that it extends beyond the low water line for a distance equal to two or three times the average water depth. This is accomplished by thrusting long brush, or small trees, out into the stream until the mat is sufficient to hold one man on a light plank. Then the material is laced together securely by wire as the mat is thickened and built outward. In placing brush the butts are staggered both within the water mat and in joining it to that portion of the mat on the slope; this avoids any line of cleavage and provides better integration for the entire structure. An upstream anchor cable frequently is necessary to retain the unfinished mat in position; as the work proceeds the addition of one or two cables securely laced to the brush provides greater strength.

In continuing the revetment, up the bank the butts of the brush are placed both up and down the slope. On the lower bank a mat 9 in. thick when compressed is advisable but this dimension may be decreased somewhat toward the upper bank. In some cases the mat is carried over the top of the dike (if any), and where overflow is a possibility the back slope of the dike is protected by planting or seeding. In pasture land the back slope is fenced to prevent it from being cut up by cattle.

4. With the brush in place on the slope ⅜-in. cables are stretched over it parallel to the bottom cables (Fig. 2) and the mat then is compressed by releasing the wires previously fastened temporarily to the tops of the stakes and using them to draw the upper and lower cables together. Finally the wires are fastened permanently to the stakes.

In some cases the top cable is replaced by a running stitch made with 10- or 12-gage wire securing the mats to the under cable and to the stakes and in others poles are substituted for the top cable by notching them and wiring them together as a top binder. A simple wire-tightening machine using a lever and cable clamp was devised for this work and has expediated progress materially.

5. The fascines along the underwater toe of the mat are each built continuous for the entire length of the revetment. The total number to be placed depends on the depth of the water; ordinarily three to five are adequate on streams of the type found in western Washington. The fascines average about 16 in. in diameter with a center, or nucleus, formed by a concrete core 6 in. square surrounded by willow or vine-maple brush. The cores are made in a concrete casting yard in 4- or 6-ft. lengths which are placed butt to butt in building up the fascines. With the brush in place the unit is bound together by 10-gage wire every foot or so.

During construction the fascines are supported by yokes or forms made of wood, spaced about 10 ft. apart. When a fascine is completed the forms are tipped to lower it to the slope, along which it is pulled or rolled down into position on the water mat. The heavy fascines plus such extra weights as may be necessary sink the water mat into place on the river bottom. In this position it is well below mean low water and far enough down the slope to prevent undercutting of the bank. The flexibility of the fascine permits them to conform to the contour of the slope, thus placing the strongest part of the structure at the point most urgently in need of protection. The fascines are held in place by ⅜-in. cables that anchor them to deadmen located at intervals along the banks.

6. The final step in completing the revetment is to provide the necessary weights to offset buoyancy; this is accomplished by weighting it with rock. Another satisfactory and comparatively inexpensive means is to place concrete blocks 5x16x16 in. in

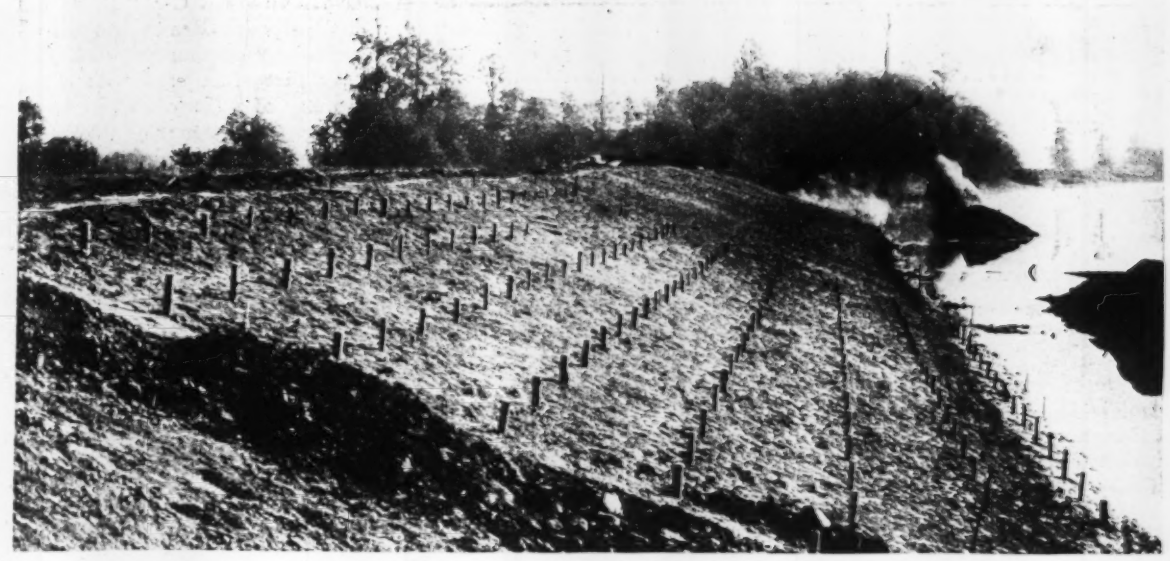

Fig. 3. Stakes are driven at 6-ft. intervals on river banks graded to a 1 on 3 slope, brush mattresses then are built, first in the water and then up to the top of the slope.

size at 6-ft. intervals and wire them to the cables or poles with 10-gage wire. The weighting is regarded as a precautionary rather than a necessary feature—European practice usually omits weights from constructions of this type.

Another precaution advisable on revetments of considerable length is to cover the mattress at intervals of about 500 ft. with gravel so as to localize any fire that may occur in the brush after it has dried out during a summer season. In streams on which logs are rafted, boom sticks should be strung along the shore to protect the mat from being gouged by floating timber and stumps.

The planting of additional willow shoots expedites the growth through the mat. In some cases later replanting is necessary when adverse climatic conditions occur. The willows must be cut over periodically as only those of small diameter provide maximum bank protection.

Cost and conclusions

The average cost of the revetment described is about $1.25 per sq.yd. In the 1937 season this cost has been lowered in many instances as additional experience has been acquired in carrying on the work. Factors affecting costs are (1) the work is being done by relief labor under relief regulations and limitations and (2) all brush used is contributed without cost to the revetment project.

A breakdown of cost reports on extensive work of this type in western Washington shows allocations about as follows: slope grading 10 per cent; brush procurement, 35 per cent; placing revetment and fascines, 40 per cent; concrete, 8 per cent; and overhead 7 per cent. An analysis on a different basis shows labor accounting for 70 per cent of all expenditures with materials and equipment costing 10 and 20 per cent respectively.

In addition to equipment operators a crew of about 75 men has been found satisfactory with assignments as follows: Overhead, shop and concrete plant 15; bank crew 35 to 40; brush crew 20 to 25. For the major items of materials used, a typical balanced bill would include, for each 100 sq.yd. of completed revetment, about 10 cords of brush, 450 lin.-ft. of $\frac{3}{8}$-in. cable, 25 lb. of 10- and 12-gage wire, and a barrel of cement. The rate of construction is about 75 to 90 sq.yd. per 100 man hours. The upper limit should be reached and possibly exceeded where work can be carried on by contract utilizing an 8-hr. day.

Experience thus far indicates that this type of revetment affords adequate bank protection on secondary streams provided a suitable growth of willows, berry bushes or similar vegetation is secured within 3 to 5 years after construction. Regular maintenance includes patching any holes in the revetment and cutting willows periodically to keep maximum diameters to a 3 or 4 in.

The work is being done under supervision of the U. S. Engineer Department, Lt. Col. Herbert J. Wild, district engineer, with the author in charge of design and construction.

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Private Construction Housing Projects Stimulate

THE HOUSING DIVISION of PWA has found as a result of investigations on the effect of its low-cost housing developments upon the surrounding areas that a total of $3,000,000 worth of private real estate improvement in the vicinity of the projects can be traced directly to the reviving effect of the housing developments on their surroundings, although in many instances the federal improvements are not yet completed or occupied.

The PWA report mentions as an example that building permits totaling $480,000 have been issued for construction in the immediate vicinity of Williamsburg houses, 1622-unit PWA project in Brooklyn, since the project was announced. Similarly, in Indianapolis, improvements definitely resulting from the project are valued at $360,709. An estimated $329,632 worth of new improvements has been made in Detroit around the two projects, Parkside and Brewster.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

CYANIDE BACTERIA—One of the more widespread trade wastes is that commonly known as "gas liquor," produced in gas works. It usually consists of a dilute solution of ammonium salts, phenols and other tar acids, salts of thiocyanic and thiosulphuric acids and small quantities of other substances. The obvious way of treating such liquid waste is in conjunction with sewage purification. Because of its poisonous nature such waste might logically be considered detrimental to any biological treatment process.

Happold and Key in England (*Biochemical Jour.* 31, 1923, 1937) have investigated the conditions of the destruction of gas liquor waste on trickling filters where a large concentration of adapted bacterial life is present. It has been found that certain micro-organisms are capable of oxidizing the poisonous ammonium thiocyanate. The rate of action of the principal organism, *B. thiocyanoxidans*, increased with time and the organism had fully adapted itself to its unusual substrate. It is believed that this is the first time that reference is made to bacterial breakdown of thiocyanate; generally cyanide is considered one of the substances that are toxic to bacteria.

CEMENT FOR SEWERS—Hydrogen sulfide production is stimulated by high temperature of the sewage, the presence of sulfur compounds, and long periods of flow before sewage reaches the outfall or treatment plant. Trade wastes containing free mineral acids, alkalis or compounds breakdown on decomposition to release acidic compounds. These substances affect concrete to a more or less extent. Surface treatment of concrete with various bituminous compounds or similar treatment of mortar joints in brickwork has been tried for protection, but it is doubtful whether such methods afford permanent remedy.

Antill (*The Surveyor*, Aug. 27, 1937) describes a number of different types of cement which have been produced for resisting the attack by sewer gas and materials in solution. Owing to its free lime content, portland cement concrete is said to be the least resistant. He finds that frequently the puzzolanic, supersulfated and aluminous cements are quite satisfactory, but when large quantities of hydrogen sulfide or free acids are present deterioration will take place. The further improvement of different types of cement, such as the high-silica product developed in this country, is held to be a more fruitful pursuit than continued search for protective agents.

HOOKWORM IN SLUDGE—There is evidence that pathogenic bacteria are destroyed during digestion of sewage solids; the organisms disappear quite rapidly and cannot be found in thoroughly digested sludge. Less information is available that hookworms, and especially their eggs, are destroyed in an ordinary digestion tank. Experiments published on the viability of hookworm eggs stored for a number of months in feces indicate that under these conditions the eggs may hatch. Some unpublished experimental evidence indicates that a small percentage of eggs may survive digestion under certain conditions.

In Singapore, India (*Ann. Rept.* Eng'g. Dept., 1936) the practice of heating digested sludge before discharge onto drying beds has been substituted as a means of destroying hookworms and their eggs. The entire mass is brought to a minimum temperature of 150 deg. F. and maintained at that temperature for at least 30 min. This effectively destroys the organism.

LAUNDRY WASTE—The treatment of laundry waste by coagulants has been practiced with more or less good success. Lime, alum, copperas and mixtures of different chemicals have been used. Comparisons made in the Russian Health Institute (*Gesundheits Ingenieur* 60, 422, 1937) show that alum used with a given quantity of sulfuric acid is most effective. An interesting method of mixing the chemicals waste is employed at Malachowa. Here the waste falls on a waterwheel which in turn mixes the chemical and allows the chemical to mix with the waste. The mixture then runs over a washboard-like trough before entering the settling tank.

SLUDGE CONCENTRATION—Activated sludge disposal is a problem because of low solids concentration. Many processes have been proposed and tried with indifferent success. Some years ago the engineer at the Barnsley (Eng.) treatment works tried the addition of sharp-grained sand as a "coagulant" for concentrating sludge. Bell (17th *Ann. Rept.* Barnsley Works) presents results covering the treatment of 3,500,000 gallons of sludge, having an average moisture content of 99.31 per cent. The process is dependent upon the coagulation of the light solid particles in activated sludge by sharp-grained dust, with subsequent settling. After sedimentation about 75 per cent of the supernatant liquor is decanted and returned to the incoming sewage. Separation of the liquor requires 3 to 4 hours, after which the coagulated sediment is discharged onto drying beds. The weight of the "coagulant" used is generally about 76 lb. per 1,000 gal. of sludge.

PURGING GAS HOLDERS—Gas produced from sludge digestion is frequently stored in gas holders. When these are first placed in operation the holder is filled with air; to prevent explosion hazards when gas is initially stored the air must be displaced. A novel method was used to purge the storage tank at the Green Bay, Wis., sewage plant when it was placed in service. (*The Water Tower*, Chicago, Bridge and Iron Co., Sept., 1937). Exhaust from sewage gas engines was discharged into the holder for a period of time. The carbon-dioxide from the engines displaced the air, leaving an inert, non-explosive gas. This was eventually displaced by the mixture of carbon dioxide and methane gas produced by the digestion process.

THE WEEK'S EVENTS

Continued from page 737

Sewage Operators At St. Paul

Big turnout for Central States Sewage Works Association shows general interest in plant operation

Problems of operators of sewage works, descriptions of new plants, researches of plant size, and trends in new laboratories were discussed at the two-day sessions of the Central States Sewage Works Association meeting Oct. 21-22 in St. Paul, Minn. Officers were agreeably surprised at the attendance, 150, since the organization, which comprises Minnesota, Wisconsin, Illinois and Indiana, had not heretofore held meetings so far from the geographical center of its member population. General interest in plant operation throughout the whole Middle West, which has manifested itself by a 30 per cent increase in membership bringing the total to 350, is held responsible for the large attendance.

George H. Radebaugh, who died during the year, had carried the organization through its infancy largely through his own efforts, officers functioning only at the meetings. W. H. Wisely, Springfield, Ill., took on the secretaryship after Mr. Radebaugh's death and was elected secretary-treasurer. Other newly elected officers are as follows: President, F. M. Dawson; vice-presidents, G. J. Schroepfer, B. A. Poole and C. C. Larson; representatives to the board of control of the Federation of Sewage Works Associations, James L. Ferebee and W. W. DeBerard.

Next years meeting will be held in the Fox River Valley (Wis.) where a cleanup has resulted in new plants at Oshkosh, Neenah-Menasha, Appleton, Kaukauna and Green Bay. Progressive sessions in several towns were proposed with headquarters in Neenah-Menasha.

Struggles with packinghouse wastes at Sioux Falls, S. Dak. were outlined in a paper by R. E. Bragstad, city engineer, and Leland Bradney, chemist. The wastes from this city of 35,000 are augmented by packinghouse wastes equivalent to an additional population of 103,000. The original 1927 plant was of the separate sludge-digestion type with sprinkling filters and was designed to care for the industrial load for a period of 10 years. Until 1931 it functioned satisfactorily. A low river and increased activity in the packing industry overloaded the plant and aeration units were added. Last year plant additions included chemical feeders, a flocculator, spiral flow aerators and final clarifiers. The plant as it now stands combines three standard methods of treatment: chemical treatment, trickling filters and activated sludge.

W. D. Hatfield, superintendent, Decatur, Ill. Sanitary District, presented the results of laboratory experiments on the viscosity or pseudo-plastic properties of sewage sludges which indicated that, until agitated, sludge acts as a plastic and then as a fluid. In consequence, formulas are in error unless related to these two types of physical conditions.

Oxygen-demand studies at Indianapolis were reported by Donald E. Bloodgood, superintendent, sewage treatment works. Control of demand of the sludge by dividing his plant into five units and, in effect, applying the sewage to the sludge in accordance with the load it could carry was the essence of his plant-size experiments. Special laboratory equipment to determine sludge oxygen demand was devised.

C. C. Wilbur, engineer, Minneapolis-St. Paul Sanitary District, described procedures used in driving the intercepting sewer tunnels in sandstone (*ENR* June 11, 1936, p. 839 and Nov. 7, 1935, p. 627). Slow progress of 1 ft. per day by the shield method has been encountered at a gorge in the sandstone 1,000 ft. wide filled with glacial deposits and water.

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Louisville Zoning Law Upheld by Court

The Kentucky Court of Appeals on Oct. 5 upheld the Louisville zoning law when it approved, in a case reaching it on appeal, a decision of the Louisville Zoning Commission. The case was brought by a firm of undertakers which had sought to convert a residence into an undertaking establishment and had been refused permission to do so by the zoning commission. The firm sought a relaxation of the law, based on the fact that there were already undertaking establishments in the restricted zone, but the commission pointed out that they were there before the zoning law became operative.

Massachusetts Road Aid To be Reduced

The U. S. Bureau of Public Roads has notified the Massachusetts department of public works that unless they can show cause to the contrary, a reduction, which may be as much as one-third of the total, will be made in he 1938 allotment of federal aid funds to that state. This action is taken under the provisions of section 12 of the Hayden-Cartwright act requiring that a reduction of up to one-third of the full allotment shall be made in the allotment to states which divert more highway tax money from road purposes than was legal at the time of passage of the act, June 1934.

The 1938 apportionment to Massachusetts is $3,171,000, made up of $1,770,000 for regular federal aid, $354,000 for secondary roads, and $1,047,000 for grade crossing elimination, and the maximum possible reduction that may be imposed because of diversion is therefore $1,057,000.

In its communication to the department of public works, the Bureau of Public Roads set forth that its understanding of Massachusetts law is that at the date of passage of the Hayden-Cartwright act no diversion was legal in Massachusetts. In 1935 the state diverted $9,500,000 of the highway funds to the general fund and in 1936 a diversion of $3,650,000 was made. In 1937 the state diverted $6,600,000 from highway purposes. The Bureau states that since the 1936 allotment, the first from which a deduction could have been made, has been completely obligated at this time, and since no finding in the matter was made during the fiscal year 1937, the first deduction will be made for the fiscal year 1938.

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Power Project Planned On Salamonie River

The Federal Power Commission has ordered a hearing to be held Nov. 12 on an application for a preliminary permit which has been filled by the Acme Engineering Service, Inc., Fort Wayne, Ind., for a 2,000-hp. hydroelectric project on the Salamonie River in Indiana.

The proposed project would consist of two dams, each with a power house, one, about a mile above the mouth of the Salamonie River, creating a 60-ft. head of water, and another, about ten miles upstream, creating a 25-ft. head. A dam creating a secondary storage of ten additional feet and not including the power plant would be located between the two. It is proposed to sell power on the open market or at wholesale to existing utility companies.

Jurisdiction Over Highways Settled in Connecticut

The dispute in Connecticut as to jurisdiction over construction of state financed road projects (*ENR*, Sept. 30, 1937, p. 573) which arose from an act of the last legislature creating a department of public works which was interpreted by the State Attorney General to give the new department control over the construction of highways, has been settled by agreement between commissioner of public works Hurley and state highway commissioner Macdonald. Under the agreement, highway work is returned to the highway department, and contracts for state aid to town roads which have been signed by Commissioner Hurley have been turned back to Commissioner Macdonald.

This action came after the U. S. Bureau of Public Roads had entered into the controversy by electing to recognize the highway department in all matters of highway improvement involving expenditure of federal funds. Four federal-aid contracts signed by public works commissioner Hurley were returned by the bureau with a request for "such adjustments as are necessary to bring the projects into line with the decision."

Attorneys of the bureau of public roads made their own studies of the Connecticut statute and decided that the highway commissioner was in exclusive charge of road construction and maintenance.

It is expected that the suit brought by the Rural Road Improvement Association, attempting to force return of highway work to the highway department, will now be dropped.

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Prefabricated Houses For Detroit Suburb

Mayor Voisine of Ecorse, suburban village near Detroit, has ordered the first 125 houses of a thousand which it is hoped to build for workers living in Ecorse, where there is an acute housing shortage. The houses, of a prefabricated type, are being purchased from the Stran-Steel Division of the Great Lakes Steel Corp. by the Wayne County Housing Corp., a public body organized by the village, and sold to workers in Ecorse industries on the installment plan under FHA insured mortgages.

The houses, of a type designed by Stran-Steel in cooperation with the architectural department of the Detroit office of the Federal Housing Administration, consist of insulation board and plywood panels made up in local lumber yards from stock materials and assembled at the site by contractors. The panels are locked into a special steel framing made up of channel sections. Facings of wood, brick, and shingles will be used, together with any type of standard roofing. The plywood side of the panel forms the interior wall surface of the room.

The prefabricated houses, with wooden siding and asbestos shingle roofing, containing four rooms and heated by an oil burner, will be sold for from $2,500 to $3,500.

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Water Works Men Meet At Sacramento

Operating problems in waterworks management featured papers presented at the 18th annual convention of the California section, American Water Works Association in Sacramento October 20 to 23. The four-day program began with a day of golf and the annual dinner of the water purification division, followed by two days well filled with technical sessions and a final day devoted to inspection trips. Points visited this year included Sacramento's sewage pumping station, two new 3 m.g. elevated storage tanks and the filtration plant. There were a score or more of assigned papers covering a wide range of current topics in operating and management and a round table discussion on items of common interest designed to encourage an exchange of ideas and experience. Attendance at the purification dinner was 325; total registration was about 570.

Good progress in the voluntary registration of sewage and waterworks operators was reported: a total of 118 waterworks operators now have their certificates, and the total for licensed sewage works operators is 107. All major cities have 100 per cent licensed operators, and 95 percent of the population of the state is served by operators holding licenses.

Among the subjects covered in formal papers were replenishment of ground waters, pipe line corrosion, the effect of temperature on water treatment, testing corrosive hazards in soils and cathodic protection for an aqueduct line.

Encouragement to a broader view of current problems was given by Eugene F. Dugger, National President, American Water Works Association, of Newport News, Va.

New officers of the California section for the ensuing year are: president, J. E. Phillips, Los Angeles; vice president, Harry Reinhardt, Berkeley and secretary-treasurer, C. M. Hoskinson, Sacramento. Riverside was selected for the annual convention which will be held in October 1938.

Court Will Review Duke Power Case

The U. S. Supreme Court on October 25 decided to review three lower court cases of interest to the utility industry. These include the suit of the Duke Power Company challenging the constitutionality of a $2,852,000 PWA allotment to Greenwood County, S. C., for the construction of the Buzzards Roost hydro-electric power plant; a case appealed from New York state courts upholding a New York City unemployment tax imposed upon utilities, appealed by the New York Rapid Transit Company and the Brooklyn and Queens Transit Corporation; and a challenge of a Louisiana tax on the generation of electrical energy as applied to power used exclusively to pump natural gas in interstate commerce.

The Duke case will be argued December 5, immediately after the argument of similar suits brought by the Alabama Power Co. against the Public Works Administration.

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Completion Items Dropped On Dam Contract

The Los Angeles County Flood Control District has authorized the West Slope Construction Co., contractors on San Gabriel Dam No. 1, to omit a number of items which are still uncompleted under the contract. The resolution provides that as soon as the contractor completes the balance of the contract apart from the omitted items, the district will accept the work as completed in accordance with the contract and release the contractor from further obligation.

This action was taken in order to permit the use of the dam for flood control and conservation purposes during the coming winter. Under the existing contract all items of work must be completed before final surveys can be made and final payment made to the contractor. The contractor is therefore unwilling to permit the use of the dam for storage purposes before completion because the storage would cause shrinkage of the fill, resulting in a corresponding loss to the contractor. Since the items to be omitted would take about six months to complete, the rainy season will be practically over by the time the work could be measured up and paid for.

The major part of the work omitted under the contract consists of concreting and other construction in connection with the outlet valves and accessories.

The items of work omitted from the present contract were readvertised and bids were received on Oct. 19.

Perisphere and Trylon Contract Awarded

Contract for furnishing and fabricating structural steel for the Perisphere and Trylon, theme building of the 1939 New York World's Fair, has been awarded by the Fair Corp. to the American Bridge Co. on its bid of $612,500.

The Perisphere will be a spherical building 200 ft. in diameter and weighing about 2,900 tons and will be supported on columns spaced around a circle 81 ft. in diameter. Each column will be 12 ft. high and will be hidden by fountains and water jets, making the sphere appear to float on the water. The sphere itself will consist of an inner and an outer shell with a space between them varying from 4 ft. at the top to 16 ft. at the bottom, where ventilating and air conditioning equipment will be installed. The inner shell will be lined with insulating and sound absorbing material.

Immediately adjacent to the Perisphere will be the Trylon, a 700 ft. triangular obelisk, which will contain the entrance and exit facilities for the sphere at a height of 50 ft. above the ground. The two structures will be connected by a bridge at this level. The obelisk will measure 68 ft. on a side at the base and each of its three sides will be a triangle tapering to a point at the top. Two escalators on each side will rise 65 ft. to the bridge. On the opposite side of the obelisk a ramp 900 ft. long will slope down to the sphere exit curving in a three-quarter circle.

The theme building was designed by the architectural firm of Harrison & Fouilhoux, and the consultants on the structural design are Weiskopf and Pickworth.

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Rain Wrecks Spillway Of Louisiana Dam

The spillway of the Valentine Lake dam in the Kisatchie National Forest near Alexandria, La., was washed out, down to creek bed level, after an unusually heavy rain of 5.35 inches during the 24 hours ending at 7 a.m. Oct. 3. The lake created by the dam was completely emptied.

The heavy rain filled the lake to overflowing and brought the spillway into use, and the large amount of water flowing over the spillway resulted in erosion of the lining. The volume of water washed out through the break destroyed fences and created sandbars for a mile downstream as well as causing some flooding of farms.

The rammed earth dam, constructed by the U. S. Forest Service with CCC labor, was essentially undamaged. The spillway was lined with creosoted timber planking.

Plans for reconstruction of the spillway have not been decided upon.

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New Orleans Drainage To Be Improved

As a result of heavy rains the weekend of Oct. 16-17 which, together with the record rainfall of Oct. 3-4 (*ENR*, Oct. 7, 1937, p. 581), have brought the October rainfall, up to Oct. 24, to 24.91 in., a number of additions to the drainage plant of the New Orleans Sewerage and Water Board have been planned. The rainfall up to Oct. 24 exceeds the previous record for an entire month of 22.71 in. in August, 1888.

The chief item in the work planned is the construction of a $150,000 pumping plant at London and Prentiss Ave. which would serve the area bounded by the Industrial Canal, London Ave., Gentilly Ave. and Lake Ponchartrain. A new canal is also to be constructed along Prentiss Ave. which, with lateral canals, will cost about $50,000. In addition, it is planned to enlarge the drainage canal connecting the South Broad and Orlean-City Park pumping station and to raise the levees of the London Ave. drainage canal.

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Eighteen Firms Left In TVA Test Case

The reversal on Oct. 20, by the Fifth U. S. Circuit Court of Appeals, of a decision in the District Court for Northern Alabama, which had stopped the Alabama Power Co. from participating in the suit which was originally brought by nineteen power companies challenging the constitutionality of TVA, brings the number of companies still engaged in the suit to eighteen. The Alabama District Court had held that since the company had started a suit against the TVA in the Alabama Court, it was debarred from participating in any other suit. This decision and a similar decision of a Georgia District Court in regard to the Georgia Power Co. had reduced the number of companies involved to seventeen.

The U. S. Supreme Court on Oct. 11 declined to review the Georgia District Court decision and thus, in effect, upheld the exclusion of the Georgia Power Company. It had been thought that the precedent established would validate the Alabama decision and thus definitely reduce the number of companies to seventeen, but unless the Circuit Court decision is appealed, the number now stands at eighteen.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

AMERICAN STANDARDS ASSOCIATION, annual meeting, Astor Hotel, New York City, Dec. 1.

HIGHWAY RESEARCH BOARD, annual meeting, Washington, D. C., Dec. 1-3.

THE ASPHALT INSTITUTE, national asphalt conference, Memphis, Dec. 6-13.

ASSOCIATION OF ASPHALT PAVING TECHNOLOGISTS, annual meeting, Memphis, Dec. 6-11.

UNIVERSITY OF KENTUCKY, road and street school, Lexington, Ky., Dec. 6-9.

AMERICAN ROAD BUILDERS ASSOCIATION, road show and convention, Cleveland, Jan. 17-21.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York City, Jan. 19-21.

ENGINEERING INSTITUTE OF CANADA, annual meeting, London, Ont., Jan. 31-Feb. 1.

REGIONAL AND LOCAL

SECTION MEETINGS, AMERICAN WATER WORKS ASSOCIATION:
Wisconsin, Green Bay, Nov. 8-10.

AMERICAN SOCIETY OF CIVIL ENGINEERS, IOWA SECTION, AND IOWA ENGINEERING SOCIETY, joint annual meeting, Ames, Iowa, Nov. 18.

NEW JERSEY ASSOCIATION OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS, Elks Club, Jersey City, N. J., Jan. 14-15.

NEW YORK STATE SEWAGE WORKS ASSOCIATION, annual meeting, New York City, Jan. 20-22.

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License Examinations

NEW YORK: Examinations for professional engineering Jan. 24-26, and for land surveying Jan. 27, at Albany, Buffalo, New York and Syracuse. Applications must be filed Nov. 1.

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Skilled Workers Tested On New York WPA

Colonel Somervell, WPA Administrator for New York City, announced on Oct. 18 that all skilled workers employed by WPA in the city have been examined as to their qualifications and that 83½ per cent of those examined had passed the tests, which were made by a special Mechanics Qualification Unit. The 16½ per cent who failed to qualify have been demoted to less skilled positions.

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

LOWER LUMBER PRICES are again the principal change this month. Southern Pine prices are 50c. to $1.00 lower in Atlanta and St. Louis; $3.00 to $5.00 lower in Birmingham; $1.00 lower in Kansas City and New York; and $3.00 lower in Philadelphia. In Chicago, 1 x 6-in. Southern Pine is up 50c., while 2-in. planks are off $1.00. Long Leaf Yellow Pine is $3.00 to $4.00 off in Birmingham. Douglas Fir prices are down $1.00 in Kansas City; $3.00 in Philadelphia; $1.00 to $6.00 on planks in San Francisco; while 2 x 6-in. planks are up $1.00 in Chicago; and in San Francisco 6 x 12-in. and 12 x 12-in. fir timbers are up $2.00, and 3 x 12-in. are off $3.00.

Cleveland cement prices are down 15c. per barrel. In Montreal, 1½" gravel is up 5c. and ¾" gravel 10c. both in Montreal and Atlanta. Crushed stone prices are 10c. lower in Atlanta and 50c. in Baltimore. Ready-mixed concrete is down 25c. in Cleveland and up 25c. in Detroit. Granite paving brick is $5.00 higher in Baltimore and Montreal. Compared with last month reinforcing bar price is 5c. per cwt. higher in Los Angeles.

Bricklayers' wage rate is up 25c. per hour in Baltimore, plasterers 15c. in San Francisco, and common labor on heavy construction 5c. per hour in San Francisco. Structural iron workers' rate in Chicago will be $1.70 effective Dec. 1, 1937.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE (Ready Mixed 1:2:4, 50 c.y. or more, delivered)
	Cloth Bags	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.84	$2.58	$2.50	$1.65	$1.75	$1.55	$1.55	$1.65	$1.55	$1.65	$8.90
Baltimore	2.31	2.06	1.86	1.80‡	1.80‡	1.30‡	1.30‡	1.30‡	1.80‡	1.80‡	7.35
Birmingham	2.40	2.15	1.95	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.25*b*	2.00*b*	1.80*b*	1.20	1.20	.80	1.20	1.20	....	....	7.00*m*
Chicago	2.45	2.20	2.05	1.00‡	1.00‡	1.00‡	1.35‡	1.35‡	1.00‡	1.00‡	....
Cincinnati	2.53	2.28	2.02	1.20	1.20	1.30	1.80	1.80	....	....	6.60
Cleveland	2.30	2.05	....	1.40	1.40	1.30	1.60	1.60	1.65	1.65	7.15*i*
Dallas	2.30	2.05	1.85	1.40	1.40	1.05	1.00	1.15	1.84	1.89	7.00
Denver	3.08	2.85	....	1.20	1.40	.90	....	....	....	....	....
Detroit	2.20	1.95	1.80	1.15	1.25	.95	1.50	1.60	1.15‡	1.25‡	6.50
Kansas City	2.55	2.30	2.06	1.85	2.30	1.15	1.85	1.80	....	....	7.90*n*
Los Angeles	2.32	2.12	....	2.00	2.00	1.70	2.00*f*	2.00*f*	....	....	7.60
Minneapolis	2.86	....	2.41	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.15*j*
Montreal	....	....	1.70*c*	.85	.95	1.15‡	1.25‡	1.30‡	....	....	6.50*l*
New Orleans	2.37	2.12	....	1.50	1.50	1.25	....	....	....	....	8.00
New York	2.50‡	2.20‡	....	1.50*de*	1.50*de*	1.00*de*	1.65*de*	1.75*de*	....	....	7.70
Philadelphia	2.55	2.30	2.10	1.55‡	1.65‡	1.25‡	2.00‡	2.05‡	1.00	1.00	8.25*k*
Pittsburgh	2.40	2.15	1.95	1.80‡	1.80‡	2.10‡	2.25‡	2.25‡	1.50	1.50	8.75
St. Louis	2.52	2.27	....	1.50‡	1.50‡	1.50‡	.85*h*	.85*h*	.65/.95*g*	.50/.85*g*	7.50
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	....	....	7.50
Seattle	3.10	2.85	....	1.17*o*	1.17*o*	1.17*o*	1.33*o*	1.33*o*	....	....	7.30*o*

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off or cash. *c* Sales tax included. *d* Per cu. yd. *e* Barge lots alongside docks. Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more *o* 2% off for cash.

CASH DISCOUNTS, CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice, in Montreal 5% if payment before 15th.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Northampton, Pa.	$1.65	$1.60
Crestmore, Calif	1.72	....	Iola, Kans.	1.70	1.65	North Birmingham, Ala.	1.75	1.70
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	La Salle, Ill.	1.70	1.65	Richard City, Tenn.	1.85	1.80
Hannibal, Mo.	1.70	1.65	Limedale, Ind.	1.70	1.65	Steelton, Minn.	1.80	1.75
Hudson, N. Y.	1.75	1.70	Mason City, Ia.	1.70	1.65	Universal, Pa.	1.65	1.60
Independence, Kans.	1.70	1.65	Norfolk, Va.	1.70	1.65	Waco, Tex. (Plus 5c. Tax in Texas)	1.75	1.70

LOWER PENINSULA, MICHIGAN. Uniform carload lot cement price established March, 1937.

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT		ASPHALT BINDERS—FLUXES		CUTBACK ASPHALT		ROAD OILS	ASPHALT EMULSION	
	Granite per M, lots of 50,000, 4x4x8 in.	Brick per M, 3x4x8½ in., carload lots	Wood per sq. yd., 3½ in. 16-lb. treat	Per ton, less than 80 penetration, Tank car	Drums	Per gal., 80–300 penetration, Tank car	Drums	Per ton, Tank car	Drums	Per gal., Tank car	Per gal., Tank car	Drums
Atlanta	$75.00	$38.85	$2.25	$18.20*e*	$23.41*e*	$0.0728*e*	$0.1049*e*	$.0768*he*	$.1089*he*	$0.0668*e*	$0.0834	$0.0834
Baltimore	140.00	44.00‡	2.50	17.00	22.00	.075	.10	.09*h*	.125*h*	.....	.....	.....
Birmingham	....	25.00	....	19.00	24.00	.0878	.1128	.102*h*	.137*h*	.....	....	.....
Boston	75.00	46.50	3.00	17.00‡	22.00‡	.07‡	.095‡	.09*h*‡	.12*h*‡	.075‡	.095‡	.125‡
Chicago	140.00	48.00	2.26	18.00	23.00	17.00*g*	22.00*g*	.07*h*	.11*h*	.05	.09	.135
Cincinnati	112.00	37.50	.....	13.47	17.47	.12	.....	11.00	.....	.051	.078	.....
Cleveland	3.75*a*‡	37.00	2.85	18.00	22.25	.081	.099	.09*h*	.10*h*	.06	.095	.10
Dallas	.....	32.50	.....	15.80	20.00	.05	.08	14.80	23.00	.05	.075	.105
Denver	.....	27.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	35.00	.....	16.72*f*	21.97*f*	.....	20.60*g*	15.60	20.60	.0535	.1125	.1525
Kansas City	.....	44.00	.....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	.....	11.00	15.16	11.00*g*	15.16*g*	11.00	.....	.042	.06	.12
Minneapolis	.....	.....	1.90*d*	21.70	26.70	.098	.137	21.85	34.65	.0638	.....	.....
Montreal	90.00*c*	60.00	3.42	14.00	20.00	.10	.13	.0975*h*	.01125*h*	.0675	.135	.165
New Orleans	.....	.....	.....	14.00	17.00	.065	.09	.07*h*	.10*h*	.....	.078	....
New York	.....	67.00	2.85	17.00	22.00	.075	.10	.09*h*	.12*h*	.....	.075	.11
Philadelphia	120.00	.....	.....	15.00	20.00	.06	.085	.065*h*	.095*h*	.055	.07	.10
Pittsburgh	115.00	40.00	.....	19.00	24.00	.077	.1125	.068*h*	.121*h*	.0475	.....	.....
St. Louis	115/130	37.00	.....	19.00	24.00	.0775	.1075	.08*h*	.11*h*	.045	.09	.12
San Francisco	.....	70.00	.....	12.00	18.00	12.00*g*	18.00*g*	12.50	23.00	.04	.0575	.117
Seattle	.....	60.00*i*	.....	25.55	25.55	19.50*g*	25.55*g*	15.50/16.50	28.50	8.15*g*	.075	.1325

‡ Delivered. *a* 4½x6x5½ in. per sq. yd. delivered. *b* 4x5x9 in. aver. *c* Sales tax included. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* 3½x4x8½ in.

(Continued on second following page)